TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE,

1874.

VOL. VII.

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE,

BY

JAMES HECTOR, M.D., F.R.S.

B.3.40

ISSUED JULY, 1875.

WELLINGTON:
JAMES HUGHES, PRINTER, LAMBTON QUAY.
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ERRATA ET ADDENDA.

PAGE

117, line 20, *for* fall *read* pall.

118, ,, 10 from bottom, *for* all *read* able.

139, ,, 13, *after* lizard *insert* "Dr. Thomson found the intervertebral plate of a small Cetacean in the cave, lying on the surface. It is 2·85 inches in diameter."

in the foot-note, *after* short bill *add* "Its nearest ally appears to be *Biziura lobata*."

200, at end of reference, *add* "31, tarsus; 32, metatarsi or toes; 33, hallux or hind toe."

344, in foot-note ||, line 2, *before* species *add* this.

401, line 17, *for* though *read* through.

405, in foot-note, *for* at end of Art. LXXV. *read* on page 461.

421, in foot-note, *after* "throughout" at end of first paragraph *insert* "*Extract from Report.*"

in the next paragraph, *for* Urunui *read* massive.

line 5 from bottom, *for* nine *read* eight.

422, foot-note, line 8, *for* shingle *read* bluish.

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NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

BOARD OF GOVERNORS.

(EX OFFICIO.)

His Excellency the Governor. | The Hon. the Colonial Secretary.

His Honour the Superintendent of Wellington.

(NOMINATED.)

W. T. L. Travers, F.L.S., Alfred Ludlam, James Hector, M.D., F.R.S., The Hon. G. M. Waterhouse, The Hon. E. W. Stafford, F.R.G.S., The Hon. W. B. D. Mantell, F.G.S.

(ELECTED.)

1874.—His Honour William Rolleston, B.A., His Honour Mr. Justice Chapman, James Coutts Crawford, F.G.S.

1875.—His Honour William Rolleston, B.A., Charles Knight, F.R.C.S., Thomas Kirk, F.L.S.

ABSTRACTS OF RULES AND STATUTES.

GAZETTED IN THE "NEW ZEALAND GAZETTE," MARCH 9, 1868.

SECTION I.

Incorporation of Societies.

1. No Society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such Society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the Society.

2. Any Society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the Members of the said Society shall at any time become less than twenty-five, or the amount of money annually subscribed by such Members shall at any time be less than £50.

3. The bye-laws of every Society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of its annual revenue in or towards the formation or support of some local public Museum or Library; or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and Library of the New Zealand Institute.

4. Any Society incorporated as aforesaid which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any Society for the time being incorporated with the Institute, shall be deemed to be communications to the Institute, and may then be published as proceedings or transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications :

Regulations regarding Publications.

(a) The publications of the Institute shall consist of a current abstract of the proceedings of the Societies for the time being incorporated with the Institute, to be intituled, "Proceedings of the New Zealand Institute," and of transactions comprising papers read before the Incorporated Societies (subject, however, to selection as hereinafter mentioned), to be intituled, "Transactions of the New Zealand Institute."

(b) The Institute shall have power to reject any papers read before any of the Incorporated Societies.

(c) Papers so rejected will be returned to the Society before which they were read.

(d) A proportional contribution may be required from each Society towards the cost of publishing the proceedings and transactions of the Institute.

(e) Each Incorporated Society will be entitled to receive a proportional number of copies of the proceedings and transactions of the Institute, to be, from time to time, fixed by the Board of Governors.

(f) Extra copies will be issued to any of the Members of Incorporated Societies at the cost price of publication.

6. All property accumulated by or with funds derived from Incorporated Societies and placed in the charge of the Institute shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all Societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the bye-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any Society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the Seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the Society.

Section II.

For the Management of the Property of the Institute.

9. All donations by Societies, Public Departments, or private individuals, to the Museum of the Institute, shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal to be given either by the owner of the articles or by

the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to Natural Science may be deposited in the Library of the Institute, subject to the following conditions :—

(*a*) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b*) Any funds specially expended on binding and preserving such deposited books, at the request of the depositor, shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c*) No books deposited in the Library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the Library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and Library, subject to bye-laws to be framed by the Board.

Section III.

14. The Laboratory shall, for the time being, be and remain under the exclusive management of the Manager of the Institute.

Section IV.

Of date 23rd September, 1870.

Honorary Members.

Whereas the rules of the Societies incorporated under the New Zealand Institute Act provide for the election of Honorary Members of such Societies : but inasmuch as such Honorary Members would not thereby become Members of the New Zealand Institute, and whereas it is expedient to make provision for the Election of Honorary Members of the New Zealand Institute, it is hereby declared—

1st. Each Incorporated Society may, in the month of November next, nominate for election as Honorary Members of the New Zealand Institute three persons, and in the month of November in each succeeding year one person, not residing in the colony.

2nd. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as Honorary Members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.

3rd. From the persons so nominated, the Governors may select in the first year not more than nine ; and in each succeeding year not more than three, who shall from thenceforth be Honorary Members of the New Zealand Institute, provided that the total number of Honorary Members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
Wellington Philosophical Society	10th June, 1868.
Auckland Institute	10th June, 1868.
Philosophical Institute of Canterbury	22nd October, 1868.
Otago Institute	18th October, 1869.
Nelson Association for the Promotion of Science and Industry	23rd Sept., 1870.
Westland Institute	21st Dec., 1874.
Hawke Bay Philosophical Institute	31st March, 1875.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1874.—*President*—Charles Knight, F.R.C.S., F.L.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., W. T. L. Travers, F.L.S.; *Council*—Dr. Hector, F.R.S., H. F. Logan, W. S. Hamilton, J. R. George, C. C. Graham, Commander R. A. Edwin, R.N., J. Blackett, C.E.; *Auditor*—Arthur Baker; *Secretary and Treasurer*—Richard B. Gore.

Office-bearers for 1875.—*President*—W. L. Buller, D.Sc., F.L.S., F.G.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., and W. T. L. Travers, F.L.S.; *Council*—Hon. W. B. D. Mantell, F.G.S., T. Kirk, F.L.S., J. R. George, C.E., C. C. Graham, Captain Edwin, J. Marchant, H. F. Logan; *Auditor*—A. Baker; *Secretary aud Treasurer*—R. B. Gore.

Extracts from the Rules of the Wellington Philosophical Society.

5. Every Member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the general meetings of Members of the Society shall be fixed by the Council, and duly announced by the Secretary.

AUCKLAND INSTITUTE.

Office-bearers for 1874.—*President*—Chief Justice Sir George A. Arney; *Council*—J. L. Campbell, M.D., J. C. Firth, T. B. Gillies, J. Goodall, C.E., D. Hay, Hon. Col. Haultain, Rev. J. Kinder, D.D., Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, C.E., T. F. S. Tinne, T. Heale; *Auditor*—C. Tothill; *Secretary*—T. F. Cheeseman.

Office-bearers for 1875.—*President*—J. C. Firth; *Council*—J. L. Campbell, M.D., J. M. Clark, W. Earl, G. F. Edmonstone, T. B. Gillies, J. Goodall, C.E., Hon. Colonel Haultain, T. Heale, Rev. J. Kinder, D.D., G. M. Mitford, J. Stewart, C.E.; *Secretary*—T. F. Cheeseman, F.L.S.; *Auditor*—C. Tothill.

Extracts from the Rules of the Auckland Institute.

4. New Members on election to pay one guinea entrance fee, in addition to the annual subscription of one guinea; the annual subscriptions being payable in advance on the first day of April for the then current year.

5. Members may at any time become Life Members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual General Meeting of the Society on the Third Monday of February in each year. Ordinary Business Meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1874.—*President*—Julius Haast, Ph.D., F.R.S.; *Vice-Presidents*—Ll. Powell, M.D., G. W. Hall; *Council*—His Honour Mr. Justice Gresson, W. Montgomery, R. W. Fereday, Dr. J. S. Coward, H. J. Tancred, Rev. J. W. Stack; *Hon. Treasurer*—J. Inglis; *Auditors*—J. Palmer, R. Wilkin; *Hon. Secretary*—C. M. Wakefield.

Office-bearers for 1875.—*President*—Julius Haast, Ph.D., F.R.S.; *Vice-Presidents*—R. W. Fereday, Rev. J. W. Stack; *Council*—Dr. J. S. Coward, H. J. Tancred, Ll. Powell, M.D., G. W. Hall, His Honour Mr. Justice Gresson, Professor A. W. Bickerton, F.C.S.; *Hon. Treasurer*—John Inglis; *Hon. Secretary*—C. M. Wakefield.

Extracts from the Rules of the Philosophical Institute of Canterbury.

7. The Ordinary Meetings of the Institute shall be held every first week during the months from March to November inclusive.

25. Members of the Institute shall pay two guineas for the first year of membership, and one guinea annually thereafter, as a subscription to the funds of the Institute.

27. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

OTAGO INSTITUTE.

Office-bearers for 1874.—*President*—J. T. Thomson, F.R.G.S.; *Vice-Presidents*—J. McKerrow, D. Brent; *Council*—Professor Black, W. Blair, C.E., A. Bathgate, R. Gillies, Professor Shand, H. Skey, P. Thomson; *Hon. Treasurer*—J. S. Webb; *Hon. Secretary*—Captain F. W. Hutton, F.G.S.

Office-bearers for 1875.—*President*—J. S. Webb; *Vice-Presidents*—J. T. Thomson, F.R.G.S., P. Thomson; *Council*—Professor Millen Coughtrey, Dr. Hocken, A. Bathgate, H. Skey, D. Brent, G. M. Thomson, J. McKerrow; *Hon. Treasurer*—R. Gillies; *Hon. Secretary*—Captain F. W. Hutton, F.G.S.

Extracts from the Rules of the Otago Institute.

3. From and after the 1st September, 1869, any person desiring to join the Society may be elected by ballot, on being proposed in writing at any meeting of the Society by two Members, on payment of the annual subscription for the year then current.

4. Members may at any time become Life Members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

9. An Annual General Meeting of the Members of the Society held on the second Monday of July.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

Office-Bearers for 1874.—*President*—Sir David Monro ; *Vice-President*—The Bishop of Nelson ; *Council*—Leonard Boor, M.R.C.S., Charles Hunter-Brown, Hon. Thomas Renwick, Joseph Shephard, George Williams, M.D. ; *Hon. Treasurer*—J. Holloway ; *Hon. Secretary*—T. Mackay, C.E.

Office-bearers for 1875.—*President*—Sir David Monro ; *Vice-President*—The Bishop of Nelson ; *Council*—Leonard Boor, M.R.C.S., Charles Hunter-Brown, F. W. Irvine, M.D., Hon. Thos. Renwick, Joseph Shephard, George Williams, M.D. ; *Hon. Treasurer and Secretary*—T. Mackay, C.E.

Extracts from the Rules of the Nelson Association for the Promotion of Science and Industry.

2. The Association shall consist of Members elected by ballot, who have been proposed at a Monthly Meeting of the Society, and elected at the ensuing meeting.

3. Each Member to pay a subscription of not less than one pound per annum, payable half-yearly in advance.

4. Ordinary meetings held on the first Wednesday in each month.

WESTLAND INSTITUTE.

Office-bearers for 1875.—*President*—Judge Harvey ; *Vice-Presidents*—Hon. J. A. Bonar, Ven. Archdeacon Harper ; *Committee*—F. Dermott, M.D., H. W. Maunsell, M.D., W. C. Roberts, J. Crerar, W. Todd, Captain Turnbull, Rev. Mr. Kirkland, Rev. Mr. Rishworth, Rev. Mr. Martin, H. Meyer ; *Treasurer*—W. Duncan ; *Secretary*—R. C. Reid.

Extracts from the Rules of the Westland Institute.

3. The Institute shall consist :—(1) Of Life Members, *i.e.*, persons who have at any one time made a donation to the Institute of £10 10s. or upwards ; or persons who, in reward of special services rendered to the Institute, have been unanimously elected as such by the Committee or at the general half-yearly meeting. (2) Of Members who pay £2 2s. each year. (3) Of Members paying smaller sums—not less than 10s.

5. The Institute shall hold a half-yearly meeting on the third Monday in the months of December and June.

HAWKE BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1875.—*President*—His Honour J. D. Ormond; *Vice-President*—The Bishop of Waiapu; *Council*—W. Colenso, J. M. Gibbes, H. R. Holder, S. Locke, J. A. Smith, W. I. Spencer, F. W. C. Sturm; *Hon. Secretary and Treasurer*—W. Colenso.

Extracts from the Rules of the Hawke Bay Philosophical Institute.

3. The annual subscription for each Member shall be one guinea, payable in advance on the first day of January in every year.

4. Members may at any time become Life Members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

(4.) The session of the Hawke Bay Philosophical Institute shall be during the winter months, from May to October, both inclusive; and general meetings shall be held on the second Monday in each of those six months, at 8 p.m.

TRANSACTIONS.

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1874.

I.—MISCELLANEOUS.

Art. I.—*The Mythology and Traditions of the Maori in New Zealand.* By the Rev. J. F. H. Wohlers, of Ruapuke, Southland.

[*Read before the Otago Institute, 7th April and 10th August,* 1874.]

Introduction.

This paper has been compiled from a number of tales collected by me in the Maori language some twenty-five years ago, when there were still a few Maori alive who were acquainted with their ancient lore. About the same time, Sir George Grey, when he was the first time Governor of New Zealand, was collecting such tales from the Maori in the north. He afterwards printed his collection in the Maori language. I do not know if there is a translation of the same. I have never seen one. In cases where Sir George Grey's collections differ materially from mine, or where they can throw some light on the subject, I have mentioned it. Where the proper names in the tales bear a clear meaning in the Maori language, I have added the interpretation, but not otherwise.

Those tales could no more be collected now—at least not here in the south; for the old Maori are dead, and the younger ones have not learnt them, because the new ideas introduced by Christianity and European settlements have superseded the old Maori ideas. The tales can only have historical worth when the mythologies and traditions of other nations, from widely different parts, can be compared with them, as thereby the migration, and the archaic place where the Polynesian race may have had its growth and development, might be traced. They may also be worth reading as curiosities.

The Maori race, as it now is, seems to be in its old age; but it must once in some former time have had its youth, when, in buoyancy of spirit and yet simplicity of mind, it saw in the surrounding nature and natural phenomena beings of a higher order, to whom the national poets gave names and a history. This must have been before they came to New Zealand, as these names, and a similarity of the mythology attached to them, are to be found among the whole Polynesian race, and may likely be traced back still farther. Ethnology might be assisted if all who are in a position among uncivilized races to do so, would make themselves acquainted with their mythology and ancient tales, and then communicate the result to scientific men, who might thereby trace the development and migration of the races. Care should be taken by the collectors to furnish only the raw material, and not to mix Greek mythology or Hebrew history with it.

The ancient tales among the Maori have been handed down through many generations by word of mouth only. The *tohunga*, or wise men among them, told those tales over and over again, almost always in the same words, so that the younger ones, who had a mind for learning, learnt them by rote, and could impart them in the same way to a following generation. Still discrepancies would creep in, and deeds which in some localities are imputed to one personage, in others are imputed to another. But that is of no consequence. Although some tales may have been built on facts, and if even these could be stript of the fictions, which they cannot, they would not be of the least historical value, as they lie altogether outside the bounds of general history.

The heathen religion of the Maori in New Zealand had got into such confusion that no meaning could be found in it. The cause of that confusion may be found in the fact that among them, at least in former times, as well as among all Polynesians, their kings or great chiefs were regarded as divine persons already during their lifetime, and that after their death they were transformed into gods. Those among them who had been great as men, would be much feared and worshipped as gods after their death, till, in the course of time, they were superseded by new ones. Through such continual changes the original gods would be neglected in fear and worship, till at last they were only regarded as historical beings without any influence. Even the deeper meaning of their history has been lost. There are some invocations and incantations to the old gods preserved, but they are not understood now, and the wise men cannot explain them. Either the language has been much changed since they were composed, or the ancient priests clothed them purposely in obscure forms.

By religion we understand a feeling of dependency in the human mind, in the consciousness of its own weakness, on a higher being, or beings; which beings are therefore feared and worshipped. But the Maori religion had lost

its hold on the old gods altogether, and had taken hold on their living chiefs and their surrounding *tapu*, or sacredness. The chief persons were *tapu*, so was all that belonged to them; and they had the power to make anything else *tapu*, which then dared not be used by any person of an inferior rank, under pain of death. If such an offender was not detected and killed by men, he was sure to be killed by the invisible power of the *tapu*. Such power seems to have consisted of departed spirits, perhaps of inferior chiefs, who could not attain to the rank of gods, and therefore occupied desolate places, especially the ruins of chiefs' dwelling-houses.

Such of the Polynesian gods as had been kings or great chiefs could only belong to such districts in which they had influence during their lifetime; but such as are known, not only over all New Zealand, but over all Polynesia, we may regard as their original gods; and they are not many.

PART I.—THE HEATHEN GODS OF THE MAORI, AND ALLEGORICAL BEINGS OF THE SAME PERIOD.

1. *Tangaroa.*

Tangaroa is known and worshipped by the whole Polynesian race as the chief god and creator of the world. His name is also well known among the Maori in New Zealand, and occurs frequently in the ancient forms of invocations. Sometimes he might be seen for a few seconds standing on the crest of the waves of the sea, when the sun happened to shine against some misty spray, but little else is known of him. According to Sir George Grey's collection he was the son of Heaven and Earth, and was the god, or personification, of the sea and the fishes. But here in the south he is affirmed to be the uncle of Heaven, and the first husband of the Earth, whose personal name as a woman and a mother was Papatuanuku. The tale runs thus:—

Tangaroa lived with his wife Papatuanuku. Once he made a journey to Kahuipuakiaki for the treasures (or ornaments) of Whakitau (not to be confounded with Whakatau, a later person). When he came back he found that Rangi (Heaven) had taken his wife, Papatuanuku (the Earth), and was living with her. Now there was to be a fight. The two, uncle and nephew, met, each armed with a spear. Rangi threw his spear first, but missed, because Tangaroa bent aside. Then Tangaroa threw his spear, which pierced both loins of Rangi and lamed him. Then Tangaroa left his wife, the Earth, and she was henceforth Rangi's wife. This is all that is known here about Tangaroa.

The following tale bears some marks of a later period; also I cannot find the names mentioned in it among the gods of the Pacific islanders; yet, as the old Maori here told it in connection with Tangaroa, I will put it here. It runs thus:—

2. *Tutakahinahina and Te Roiroiwhenua.*

Tutakahinahina walked upon the waters. He had no parents. His wife's name was Kaihere. They had one son, called Te Roiroiwhenua. When the son was born, Tutakahinahina told his people to get in a good supply of food and firewood. Then he died, and was buried by the wall inside the house, the face downward and the back upward. The grave was fenced round. Now the sun was withheld by Kumeateao, by Kumeatepo, by Unumiatekore. Then it was dark on sea and land. The darkness was so great that no road could be seen to fetch food and firewood. The people used what there was in the house. Then they broke up in the house what they could, to keep the fire burning. At last Te Roiroiwhenua heard the voice of his father, speaking in his grave: "Here I am buried, look where the earth heaves up." Then Te Roiroiwhenua went to the spot and listened. He heard a gnawing inside the grave; it was the maggots, gnawing at his father. Then he saw two of them crawling out of the grave inside the fence, a male and a female. He caught the male, to be roasted in an oven; but the female he let go. The oven was heated with sacred fire. Then Tamatea (perhaps identical with Tawhirimatea, the personal name of the wind) came and shook the oven. Now there came a start, and the first sign of the morning appeared. The morning advanced. First the birds sang: "Light of the day." Then the people shouted: "Daylight."

Some of the Maori *tohunga* say that Te Roiroiwhenua is identical with Tangaroa; others say he is not—only before, the Morning was with Tangaroa; but after the shaking of the oven, the Morning was with Tamatea. Perhaps the tale is a skeleton only, left of what may have been a good poem, the deeper meaning of which has been lost.

3. *Rangi and Papatuanuku.*

Rangi means Heaven in the common language, and is here used as a proper name, but Papatuanuku is the personal name for the Earth (*te whenua*). These two were not worshipped as gods, but were regarded as the parents of all visible nature.

Rangi, having been lamed in the duel with his uncle, could no longer stand upright, and had, therefore, to lie always flat on the earth. The consequence was a still darkness; no wind could blow, no light could shine. Notwithstanding they had many children. Most of them were cripples; some had crooked, drawn-up legs, some had stiff stretched out legs, and other deformities; however, a few had sound limbs. The most conspicuous among the latter was Tane; also Paiao (Cloud), Tawhirimatea (personal name of the Wind), deserve to be mentioned. In Sir George Grey's collection, the following children of Heaven and Earth are named:—

Tangaroa	the personification	of	the	fishes
Rongomatane	,,	,,	,,	kumara
Haumiatiketike	,,	,,	,,	fernroot
Tanemahuta	,,	,,	,,	trees and birds
Tawhirimatea	,,	,,	,,	wind
Tumatauenga	,,	,,	,,	mankind.

The children felt very inconvenient in that close darkness, and the more able ones among them held a consultation of what to do, in order to gain light and liberty. Some were for killing their father; others proposed to lift him up, and there let him live as a stranger to them. The counsel of the latter prevailed. After this they set to work. First Paiao (Cloud) tried, but could not lift him. Then Tane tried, with no better result. Then they tried all together; but Heaven was too heavy for them. At last Tane put his head on the ground and stretched his legs upward. That succeeded. Rangi cried and lamented that he was ill-treated by his children; but they carried him up, and then Tane fixed him.

It seems that Tawhirimatea (the Wind) took no part in this movement, but rather that he had opposed it from the beginning, counselling to let things remain as they were. This seems rather strange of such a restless fellow as the Wind; but the northern natives, according to Sir George Grey's collection, account for this by saying that Tawhirimatea was a quiet, loving boy before, but that, when he was outvoted by his brothers, and Heaven and Earth were separated against his will, he became dissatisfied and restless. He followed his father heavenward, and talked to him about the injuries he had received from his children, and then came down again, fighting with his brothers from all quarters of the heavens.

When Heaven had been carried up, and Tane had fastened him, and then come down again to the earth, he (Tane) looked up to his father; but the old man looked dark and sad. Then he went to Okehu, to fetch ornaments for his father. With this he put on him a bright polish. When he came down again and looked up, he thought his father did not yet look so good as he ought to; so he fetched more ornaments, and with these he drew the Milky way, painted the Magellan Clouds, and set the constellations. This done, he came down again to see how that did suit his father. Now he looked handsome.

Now Tane looked at his mother, who was still void of ornaments. So he raised some of her crippled children, and put them upright, as trees. First he put their legs downward and their heads upward, and then went aside to look at them. But the trees did not look well in that position, standing on their branches, with their stumps and roots as heads and hair, up. Then he took them up again, and put their heads down and their legs, the branches, up; and went again aside to look. Now they looked good; now both parents were adorned with beauty.

Though Rangi and Papatuanuku have now been long separated, yet their love toward each other continues. Her sighs out of her bosom may be seen ascending up to Heaven in the vapoury mist that rises from the wooded mountains; and Heaven weeps his tears of love down upon her in dew-drops.

4. *Tane.*

All over Polynesia, Tane was held to be a great god, next to Tangaroa. In New Zealand he superseded Tangaroa in importance. The word *Tane*, in the present language, means man or male; but I do not know if the name indicates any meaning. His full name was Tane nui o Rangi (Great Tane of Heaven). In Sir George Grey's collection he is called Tane Mahuta, and there he is made the god, or personification, of trees and birds. There are also indications here, in the south, of his having had to do with woods and forests, but a great deal more with the origin and final destiny of mankind.

When Tane had separated Heaven and Earth (his parents), and adorned each with becoming beauty, and was now at his leisure, he wandered about among trees and birds to find a wife for himself; but found none. Turning to his mother for advice, she directed his attention to Hinehaone, a maid formed out of the soil. With her he had one daughter, called Hineatauira (Maid of the glistening Morning). After this, the mother, Hinehaone, is lost sight of, and when the daughter, Hineatauira, grew up, she became Tane's wife, without her knowing that he was her father. They had several children, the names of which indicate a drawing toward death, corruption, and the world of night.

Once Tane made a journey to the heavens, to visit his elder brother Rehua. Who, or what, this Rehua may have been I cannot find out, except that he dwelt in the tenth strata of the heavens. When Tane came to the first heaven, he called up: "Are there men above?" The answer was: "There are." "May I come up?" "No, this is the heaven that has been stretched out by Tane." Still Tane went up, and onward, till he came to the second heaven, when he again called up: "Are men above there?" "There are." "May I come up?" "No, this is the heaven that has been painted by Tane." Still he went up, and onward, till he came to the third heaven, when again he called up: "Are there men above there?" "There are." "May I come up?" "No, this is the heaven the bounds of which have been fixed by Tane." So he went on through other strata, till he came to the tenth heaven, where he found Rehua. When the two met, they both sat down to have a cry together. Rehua cried simple, but Tane cried, with a meaning, in verses. The verses are hard to be understood, and, if translated, would not carry with them the poetical beauty they bear in Maori. They begin as if he had met Rehua cultivating the soil; and are then to the effect that the ground is cleared, carpeted, and beautified by the cultivator, which adds to the splendour of

Heaven ; and then end : "Whatever be thy name, it was Tane who has set the Heaven." Hereby Tane made himself known to Rehua.

When Rehua had learnt, by the crying, that his visitor was the great Tane, he had a fire made, and empty vessels brought. Tane wondered where the food was to come from. Presently Rehua untied his head, and shook out of his hair a lot of birds, *tuis*, into the empty vessels, and then had the birds killed and cooked. But Tane did not eat of them, because it is against the *tapu* religion for an inferior to eat anything that has been in contact with the body of a superior, and Rehua is called Tane's *tuakana*, which means either an elder brother, or a descendant from an elder branch of a house. Then Tane asked : "Cannot I catch some birds?" "Yes," answered Rehua, "when the trees bear fruit and the birds feed on it ; when the wind blows and their throats get dry, and they fly to the water to drink, then snare them."

There is more of the tale of this sort, as when Tane went to another place in that region, where people lived on rats and were out rat-catching; but I can see no meaning in it. In Sir George Grey's collection, this sort of tale is attributed to a visit of Rupe to Rehua. Now Rupe is a different person from Tane, and belongs to a later period. Also this catching and cooking of birds and rats seems to indicate a later period than that of the gods. But the following is more godlike again:—

While Tane was absent, Hineatauira asked her mother-in-law (the Earth) : "Where is my husband?" "What!" replied Papatuanuku, "thy husband! he is thy father." When she heard this she felt so much ashamed that she took leave of her mother-in-law, and went away to the world of night below.

When Tane came home again from his journey to the heavens, he asked his mother : "Where is my wife?" "Thou hast no wife any more," was the reply ; "she is gone to the Po (world of night)." Then Tane also went down to the nether world, to bring her up again, if possible. There he wandered about for a long time in a lone, dim, shadowy night. At last he came to a house, but saw no living being. All was still. He spoke toward the pillar of the house, but received no answer ; he spoke toward the gable of the house, but received no answer. Then, when he went confused and ashamed along the wall of the house, he heard some one inside the house, calling out to him : "Where, Tane, art thou going?" "I am following our sister," he replied. Then that one inside said :—

"Go back, Tane, to the world of light,	"E hoki, e Tane, ki te ao,
To train up our children.	Hei whakatupu i a taua hua.
Leave me here, in the world of night,	Tukua au ki te Po,
To draw down our children."	Hei kukume i a taua hua.*"

* *Hua*, literally, means fruit.

5. *Maui.*

We now come to a strange person—not a god, and not like other men, neither good nor yet absolutely bad; but always dealing in mischief and wicked practical jokes. It is certainly an ancient personage, for itself and its deeds are known and talked of by the whole Polynesian race. The word *maui*, in the present language, means left, or left-handed; but I do not know if any meaning has been intended by this proper name. Maui's father's name was Raka or Ranga, his mother's Hina, according to the southern Maori; in the north they give them different names. The following names of their children are mentioned: Maui-mua (*maui* before); Maui-roto (—inside); Maui-waho (—outside); Maui-taha (—at the side); and Maui-potiki (—the youngest of a family). The last one is our hero; he only is simply called Maui; the brothers are distinguished by their adjectives.

Maui, at his birth, was such a shapeless lump that his mother wrapped him in a rag and cast him into the thorn bush. There he was found and nursed by his ancestors, Mu and Weka (names alluding to wingless birds in the bush). According to Sir George Grey's collection, as told by the Maori in the north, she cast him among the kelp on the sea-beach, where he was washed about by the tide among the seaweeds, the sea-birds screaming over him, till he was found and nursed by his ancestor, Tamanuikiterangi (great *Tama*, or Son, toward Heaven). After he had been nursed into a child's shape, he was taken up and trained by Aonui, Aoroa, Aopouri, and others, all names which allude to phenomena in the sky. Here, for mischief's sake, he put snow on the cultivation of one Marutewareaitu, and injured it. Then Marutewareaitu put caterpillars on Maui's cultivation, which destroyed it. Then Maui waylaid Marutewareaitu and killed him. The wise men among the Maori admit that they have lost all meaning about this tale. There is more about it in that region, but all is confused and meaningless. After this, Maui was sent home to his parents.

When he came to the place of his parents' house, he found his brothers outside, playing at throwing spears at a mark. Maui joined their sport, and then threw his spear at the gable of the house with such force that one of the gable boards came down with a clattering noise to the ground. Upon this the mother rushed out of the house, scolding her children for destroying the house. "We have not done it," said they, "it is that boy there," pointing at Maui. "Whose boy are you?" asked the mother. "Your own," answered Maui. "No, you are not," she replied; "these are my children; you are a stranger." "That may be," said Maui, "yet I am your son. You wrapped me in a rag, and cast me in a thorn bush. My ancestors have nursed me into life and shape, and have brought me up." Then his mother remembered. She

now recognised him, cried over him, and then kept him by her with her other children.

Maui had now found his mother and brothers, but he had not yet seen his father. At night, when they were all in bed, and all was dark, he heard that his father was in the house, and that his mother was telling him of himself, their castaway son, who had come home alive. Next morning, when it was daylight, his father was gone. He asked his brothers where their father was, but they could not tell him; they seemed to be so used to his mysterious absence that they felt no curiosity about it. When he asked his mother, she did not answer him. This made him curious, and he resolved to find out the mystery. Next night he kept awake, but pretended to be asleep. By and by he heard, in the dark, that his father was in the house again, that he untied his *maro* (that piece of cloth which savages wear round their loins), folded it up, put it aside, and then went to bed. When all were asleep, Maui got softly up, took his father's maro, and hid it. In the morning, just before daybreak, his father got up and felt for his maro, but could not find it. While he was thus delayed by seeking, daylight appeared, and then he hastily moved a post of the house, and disappeared below it. Maui waited till all were up and out of the house, then he moved the post, as he had seen his father do, and discovered a subterranean passage below. He put the post in its place again, and said nothing about it.

That day he was going with his brothers to the woods to spear pigeons. He asked his mother for some oil, which he took with him; he also took some charcoal. When they came to the bush, then he anointed his limbs with oil, to make them pliable. Then he drew his feet into the shape of pigeons' feet, and stroked his arms into wings; his lips he drew into the shape of a pigeon-beak, and so on till his whole body resembled that of a pigeon. Then he tied the maro of his father round his neck and let it hang over his chest, and then finished off with the charcoal to imitate the shades of the colours of a pigeon. Now he could fly up the trees, and the pigeons were not afraid of him, and he could catch as many as he wished. When they came home, Maui had a large bundle of sound pigeons, while his brothers had only two or three each, much lacerated by spear wounds. Next night he heard his mother telling his father about him, that he was such a good boy; had brought home such a load of pigeons, and not at all lacerated by spear wounds.

Another day Maui thought he would explore the subterranean passage through which he had seen his father disappear. So he moved the post and went in. As he went along the passage widened, and then he came to an open place, in the distance of which he saw men at work in the field. Now he made himself again into the shape of a pigeon, took, in his flight, two or three circles

round the field, and then perched upon a low tree near the men at work. "There is a pigeon for us," called one of the men, and then took a snare, fastened on a rod, to slip it over its head. But the pigeon flew away to another tree when he came near, and so on, till, by the voice and appearance, he had recognised his father and then flew and perched upon the pole-like tool (*ko*) with which his father was turning up the ground, and cooed to him. Then his father said, "Thou art not a real bird; thou art a man from the world above." The pigeon nodded its head (backward, as was the custom of the Maori formerly), and flew down to the ground, changing at the same time into his natural shape of man. Then they had a cry together. The father cried without meaning, but the son cried in verses (I do not understand them), and thereby made himself known to his father as his castaway son. After this they went to a house together in that region.

In the neighbourhood of that place there dwelt a grandmother of Maui, of his mother's side, called Mahuika, who was the keeper of the fire. Now it happened one day that the fire had gone out; and as the servants were lazy and did not move when told to go to Mahuika to fetch fire, Maui offered to go. When he came to the place, the old woman said, "What has brought you, a stranger, here? Was it the wind, that blows against my skin?" But when Maui told her that he was her grandson she became very friendly, and willingly gave him a stick of fire—namely, one of her fingers. Maui went away with it, but extinguished it, when out of sight, in the nearest water. Then he went back and asked her for another stick of fire, saying the first was gone out. So she gave him another of her fingers, which he likewise extinguished, and so on, till he had carried away all her fingers and her toes, up to the last little toe. Then the old woman perceived that he was mocking her, and became very angry, by which she raised a great blast to burn him. But Maui quickly transformed himself into an eagle and swung himself up to the clouds. From thence he sent down rain upon the fire to quench it. Mahuika stirred up her fire to make it burn. Maui poured down large drops of rain upon it to quench it. Mahuika raked together her fire to keep it alive. Maui showered down thick snow upon it to extinguish it. At last, when the old woman saw that she could not keep her fire alive, she cast the rest into trees; in some it stayed, in others not, out of which former it can still be got by rubbing.

After this, when Maui had put himself again into his natural human shape, he went back to the place of his mother and brothers. In that neighbourhood there lived a grandfather of his, to whom his brothers carried the food when the mother had cooked it. The brothers had got tired of that work, so Maui offered to carry the food. But he only carried it behind the house, and there left it, and so let the old man die. After some time he went

into the hut of his grandfather, his name was Murirakawhenua, to see how he was, and found the old man dead. One side was still fresh, but the other was decayed. Maui broke out the jawbone, took it to the water, and cleansed it under incantation to make it into a charmed fishhook, and then hid it.

In Sir George Grey's collection there is this difference about this same tale, that Murirakawhenua was not a grandfather, but a grandmother, and that she was not dead when Maui went to her hut, but only angry, and first swelled herself to swallow him, but became friendly when she heard that he was her grandson, and that she gave him her jawbone with a good will.

Maui being always up to some mischief, his brothers had become quite afraid of him, and would not let him go out with them on the sea to fish. But having provided himself with a line, and having the jawbone of his ancestor in his possession for a fishhook, he went in the night into the canoe and hid himself in the basket with the fishing lines. Early in the morning his brothers came and launched the canoe, and paddled out to the fishing ground. Then, to their astonishment and dismay, they found Maui under the fishing-tackle. Some said he should be put on the shore again, but others said he might remain in the canoe, but should have no hook. By and by Maui said, "I am provided with hook and line, only give me a bait." But that was refused him. Then he pulled his own nose till it bled, and when the blood had clotted he put it on his hook (the jawbone), and let his line down. It soon fastened, and then there was such a commotion in the sea that even the mother felt it on shore, and exclaimed, "There, the boy is at his mischief again!" The brothers screamed for fright, "Maui, let go thy fish; let go, it is a monster." But Maui very calmly said, "This is the fish I have come to catch," and kept on pulling up. When he had got it to the surface it proved to be the bottom of the sea; but it was just like any other land. There stood houses and *whatas*; the fires smoked, the dogs barked, and the people talked.

It is also said that Maui took a wife, the daughter of Tuna (eel) and Repo (swamp), and that he cut his father-in-law into two parts; the tail swam to the sea, and became the sea-eel, and the head swam up the fresh-water courses, and became the fresh-water eel.

Now it happened that the Sun got lazy; he got up late in the morning, then went badly over his course, and went to rest again early in the evening. Maui would not allow that; for when his wife began to heat the oven in the morning, it was night again before the food was done, and he had to eat his dinner in the dark. So he persuaded his brothers to assist him to catch the Sun, when he would make him do his work properly. Having provided themselves with a long and strong rope, they went in the night to the mouth of the cave, through which the Sun comes forth in the morning. Here they

made the rope into a noose, and laid the same round the opening of the cave. Then Maui stood on one side, holding one end of the rope, and his brothers stood on the other side, holding the other end. Maui told them to let the Sun get his head fairly through, and then, when he called out, to pull with all their might, but not before. When they had thus stood for awhile, there came first a glimmer, then a fiery redness. Then the fiery hair of the Sun, all standing on end, appeared through the opening, and after that the head and glowing face came up. When the head was so far up that the noose could catch the neck, then Maui called out to pull; and the Sun was caught. Now Maui beat him for his laziness, and the Sun cried, "Maui, let me go. Maui, why dost thou beat me? Maui, let me go." At last, when the Sun had honestly promised to rise earlier in the morning, and to set later in the evening, and to run his course properly, Maui let him go.

After this Maui went to see his sister—for it appears that he had a sister. Her husband's name was Irawaru. Maui became disgusted with him, because he was a greedy man at meals. One day, when they had eaten, Maui said to him, "Come out with me; pick over my head." So the two went out; Maui laid down, and Irawaru picked over his head. Then Maui said, "Now lie down; let me do your head." While Maui's fingers wènt through Irawaru's hair, the latter fell fast asleep. Then Maui pulled his ears to the length and shape of dogs' ears; then he pulled the mouth and jaws to a dog's face, and so all over the body, limb by limb, not forgetting to pull out a tail behind; till he had transformed him into a dog. After that, he went a little way off, and then called him as a dog is called. Then Irawaru got up and showed all the manners of a dog. When Maui went into the house, his sister asked him, "Where is your brother-in-law?" "Outside; call him." His sister did so, but her husband did not come. "Call him as a dog is called," said Maui. "My husband a dog!" said his sister, feeling hurt. Nevertheless, she called at last with a sound as if calling a dog; and then her husband came, transformed into a dog, wagging his tail and whining round her. "O, Maui," cried his sister, "thou didst not consider that he was thy brother-in-law." She then sat down on the ground and cried a long and touching wail, and then went into the sea to drown herself. However, it seems that she was not drowned, but washed on a distant shore, where she was revived; and then there is another story about her, but it seems to belong to a later period.

Even Maui's death was attended with nonsensical mischief. He would try to get back out of the world, by the Goddess of Death, Hinenui o te Po (Great Maid of the World of Night,—identical with Hineatauira, her former name), as children are born into it; but that is not interesting to civilized people.

PART II.—THE PERIOD OF THE ANCIENT HEROES.

THE following tales are so well connected with one another that they seem to rest on an historical foundation. I am inclined to think that they refer to a period when the ancestors of the Maori race were migrating among the East Indian Islands, or thereabout, where they must have come in contact with such different races as these tales show they have, and that the ugly people spoken of as belonging to the whale kinds may have been tribes of the Negro race. The dwellings in the sky, mentioned in these tales, will easily be understood to mean islands lying beyond the visible horizon, where the sky and ocean appear to meet.

1. *Kaitangata and Whaitiri.*

Kaitangata means a man-eater; but this formidable name had nothing to do with his character: on the contrary, Kaitangata was a simple, harmless, man; but there was a woman, named Whaitiri (Thunder), who dwelt in the sky, and who was very fond of human flesh. When she heard that there was a man on earth called Kaitangata, she believed him to be a real cannibal, and therefore came down and took him to be her husband; but was disappointed, when she afterwards found that he was such a simple man.

Kaitangata's time was mostly occupied in fishing, to provide for their daily food; but he caught very little, and often came home without any fish because his hooks were not barbed. He was either too simple to understand his wife, who wanted to teach him better; or her designs were too wicked, and he was too good, to adopt them. At last she made a net for herself; and one day while her husband was out fishing, she saw a canoe passing by, with two men in it. Having armed herself with a stone weapon, and taking her net, she went and swam toward the canoe, now diving, now coming to the surface again. When the two men saw her they wondered if it were a bird or a human being. She had now reached the canoe and was diving under it. One of the men took a spear to have a thrust at her; but while he was bending over she came suddenly up and struck him with her weapon, ripping him quite open, when he fell into the sea and she caught him in her net. Now the other man tried to spear her, but met with the same fate as his companion. Then Whaitiri swam back to the shore, dragging her net behind her. She left the net in the water and went home and told the women there to go and fetch home the fish she had caught. By this time her husband had also come home and, as was often the case, without fish. So he assisted the women to draw up his wife's net; but they were horrified to find instead of fishes the net filled with arms and legs and other mangled parts of human bodies. Whaitiri insisted that they should be cooked.

But now there arose a difficulty: there was no priest to perform a religious ceremony over the slain bodies, and without that it would not be safe for health or life to cook and to eat them. Then Whaitiri turned to her husband, Kaitangata, requesting him to perform that ceremony. But he answered, "I do not know how to pray." His wife insisted that he should perform that ceremony, telling him that it was his duty for their child's sake—for she was then advanced in pregnancy. But to all her demands he only answered: "I do not know how to pray." At last she tried herself, but not being initiated into that mystery, she could only imitate a priest's invocation, and produced nothing but a mumbling sound. After this the human flesh was cooked and eaten, but, as it appears, only by Whaitiri. The bones were tied up and hung under the roof of the house. Her husband afterwards used some of them for fish-hooks, with which he caught more fish than he had done before. In due time a son was born, who was named Hema, who will be the next link in this generation.

Some time after that cannibal-feast Whaitiri found that she was losing her eye-sight. Then one night while she was troubled in her mind about it, there appeared to her a woman from the nether world, who said: "It is because the bones of the slain men, lacking due invocation, have been used by thy husband as fish-hooks, and thou hast partaken of the fish so caught." It may be wondered why her suffering was traced to such a secondary cause, through hooks and fish, and not direct to the eating of the men; but such is Maori reasoning.

Whaitiri's eye-sight did not get better; she was therefore generally sitting in the house. One day Kaitangata had visitors. They were all sitting outside talking, except Whaitiri, who alone stayed inside the house. Then one of the visitors, a female, asked Kaitangata: "What sort of woman is that wife of yours?" "That wife of mine!" he replied, "her skin is as cold as the wind, her heart is like snow." He did not know that his wife had heard every word. When the visitors were gone and he came inside the house his wife asked him: "What have you been talking?" "Nothing in particular," he replied. "What have you been talking about?" she repeated. "Only common talk," he replied. "What have you been talking about me?" she asked again. "O, Whai-tane (man-pursuer or husband-hunter) asked about you, that is all," he answered. But she had heard all and was sorely offended. She spoke to her son Hema thus: "You cannot come up to me. When you have posterity they may come up to me in the sky." Then she jumped up. Her husband tried to catch her by the clothes to hold her back, but was too late. She went up to her former home in the sky, to a place called Puotetoe (bunches of reeds).

2. *Hema.*

When Hema, the son of Kaitangata and Whaitiri, was grown up, he took to wife Karenuku. They had three children, a daughter named Pupumainono and two sons named Karihi and Tawhaki; the last, though the youngest, will be the next link in the generation. Hema, the father, was slain and the mother taken a captive by the Paikea, Kewa and Ihupuku people. The names of these people allude to different kinds of whales, and are spoken of as ugly and disgusting.

In Sir George Grey's book on the Maori mythology (in the Maori language), there is a beautiful tale of how the two young men, Karihi and Tawhaki, liberated their mother out of the captivity in which she was held by a disgusting people. But that tale is not known here; I must therefore leave it out.

3. *Karihi and Tawhaki.*

When the children of Hema were grown up, the two boys, Karihi and Tawhaki, made excursions over the sea in order to avenge the death of their father; but they could not find the land of their enemies. Once, when they came home from a fruitless voyage their sister, Pupumainono, said to them: "You should have asked my advice." Then she taught them an invocation, by the reciting of which she said they would be more successful.

It will be remembered that the grandmother, Whaitiri, having taken offence, left her husband and child and went away to her former home in the sky. That place, it seems, was not in a perpendicular, but in an horizontal direction, far away over the sea. By virtue of the invocation taught them by their sister, the two young men, Karihi and Tawhaki, found the place of their grandmother. The old woman, who was now quite blind, was sitting among bunches of tall reeds, beating about her with a weapon, so that if anything came within her reach she would kill it, and then add it to the store of her food. She happened to be in the possession of ten pieces of provision which she was in the habit of counting now and then feeling them with her hands. She did not know that her grand-children were then standing before her and watching her movements. So she began to count her provisions: "One, two, three," and so on. But meanwhile Karihi took away one piece, and when she had counted so far as nine she felt about for the tenth, but it was nowhere. Thinking she might have made a mistake, she began again to count: "One, two, three," and so on. But now Tawhaki had also taken away a piece, and when she had counted as far as eight, then there was no more to be felt. Again she began to count, but found every time that there was a piece less. Now she suspected that she was being robbed or made a fool of, and became very angry, scolding and beating about; but her grandsons kept out of her reach.

When her rage had exhausted itself and she was calmed down, then Karihi went near her and struck her a gentle slap on one of her eyes. She started and uttered an exclamation of joy, for with it there had come a light in her eye. Immediately, Tawhaki hit her a gentle slap on the other eye, with the same result. Now her eye-sight was restored; and when she then learned that the two handsome young men were her grandsons she became very friendly and asked them what the object was of their coming to her. They told her that they were going to avenge the death of their father, and wished her to show them the way. "Stay with me for a while," she said; "by and by I will show you." Then she took them to her house near by.

It seems that they had already partly avenged their father's death when they liberated their mother from captivity, but the accounts about that are not clear here, therefore I left out that part—it is clearer in Sir George Grey's collection. However, there are several people named who had taken part in that murder, and it may be that there was still a party left who had not yet been punished. The young men did not feel at ease in their grandmother's house, for in it there lay a large heap of human bones, the flesh of which had been eaten by her. They could not trust her; they feared that she might kill and eat them also. So they determined to be very watchful. But it was impossible to keep awake always, and she might kill them while asleep. They must, therefore, try to deceive her. For that purpose they went to the sea-shore and got some shells from the rocks, which looked just like eyes. When they put them on their closed eyes they gave them the appearance of open eyes. Then, at night, when they could keep awake no longer, they fastened the shells over their eyes and went to sleep, and when their grandmother looked at them she believed that they were wide awake, and was therefore afraid to kill them.

However, the young men did not like to prolong their stay, and kept on asking the old woman to show them the road. But she put them off, saying, "by and by she would show them." After some time and trouble she showed them a path, and then they took leave and went on; but they found that the path only led into the bush, where firewood had been carried, and no farther. So they had to go back and beg the old woman to show them the right road. After some delay and more deceiving she at last said: "Well, if you are determined, I hold the road to that part of the sky you want to reach." "Then, where is the road?" they asked. "The road is on my neck," she replied; "loose this cord." When they had untied the cord on her neck they found that the other end was fastened to the sky. "Now," she said, "you must climb up by this cord. But I am afraid the wind will blow you from one side of the heavens to the other, and you will lose your hold and fall down;

yet, if you are determined to go, mind with whom you may meet on the way. If you meet with women who talk much and behave in a rude way, have nothing to do with them ; they are some of Tangaroa's descendants. But if you meet with women who walk quietly and behave modestly, they are of your own nation, and you may make friends with them."

After these instructions the ascent began. Tawhaki remembered the prayer his sister had taught him, and said it; but Karihi forgot to say his prayer. Karihi climbed before, and Tawhaki after him. When they were a little way up the wind began to blow, and swung them, first to one side of the heaven; then the wind changed, and swung them to the other side. Karihi could hold on no longer; he fell down and was killed, and afterwards eaten by Whaitiri. Tawhaki came down so far as to see the fate of his brother, and then climbed up again till he reached a land in the sky.

The first person he met was Tuna (eel), who came down from places (or descended from persons; it is not clear), the names of which denote shining phenomena and lightning. Might that allude to electric fishes in some waters of hot climates? *Kawa* (bitter, as pepper) and *Maraenui* (great courtyard or sacred enclosure) were hanging over Tuna's forehead, like veils. Probably there is some allegory in this, but I do not know the meaning of it. Tawhaki asked Tuna: "What are you coming down for?" Tuna answered: "The above is burned up, is hard and dry, there is no water."

After that he met a company of women ; but, as they talked much and were not modest in their behavour, he remembered that he had been warned against them, so he kept out of their way. Soon after, he met another company of women, different from the former; they did not talk much, and behaved modestly ; with them he made friends, and stayed at their place. One of these women, named Hine-nui-o-te-kawa (Great Maid of Pepper) took a fancy to Tawhaki. She was the wife of Paikea (a species of whales). Paikea did not like that, and when they were sitting and talking, Paikea grinned at Tawhaki, and Tawhaki grinned at Paikea. The end of it was, that the woman left Paikea and become Tawhaki's wife.

When Tawhaki had lived a good while with his wife, and she was far advanced in pregnancy, it happened one day that they were short of firewood ; and when the dependents were in a lazy mood, and would not get up to fetch some, Tawhaki went himself and brought home a large long piece. From this occasion, the child, which was born not long after, was named Wahie-roa (a long piece of firewood)—It is still sometimes the custom of the Maori that, when an offence is taken, a name corresponding to the vexation is given to a child. Wahieroa will be the next link in the generation.

After this the tale about Tawhaki becomes hazy, and I cannot find much

meaning in it. He went to the sky or heaven of Tama-i-waho (son on the outside) to avenge the death of his father. He found Tamaiwaho's place crossbarred, but got over it. Tamaiwaho retired behind another crossbar, and called to Tawhaki: "What are you pursuing me for, you ugly man?" Tawhaki replied? "I am a handsome man, you are the ugly man. Give over some to me as a satisfaction for the murder of my father." "Never, never," cried Tamaiwaho. Tawhaki got over the barricade and Tamaiwaho retired behind a third. There some fighting happened in which Tama was wounded. Then he called to Tawhaki; "You are a handsome man." "Give over some to me," cried Tawhaki. Tama gave over some, and then said: "that is all." "Give up all," demanded Tawhaki. Tama gave up to him Ateatenuku, Ateaterangi, Harihangatepo, Harihangateao, Koruehinuku, Mataatawhaki, and others. If these names represent persons or places I do not know. Possibly they are names of stars, or may signify islands.

In Sir George Grey's book are different tales about Tawhaki. There, they end with an interesting tale of Tawhaki going up to the sky in pursuit of his wife, who had left him in a pet for a trivial offence. But that tale is not known here.

4. *Wahieroa.*

When Wahieroa, Tawhaki's son, was grown up, he took to wife Matokarautawhiri. In the course of time the wife became pregnant, and then had a wish to eat a bird, a *tui* (*koko* in this dialect), and her husband went into the bush and caught her one. Some time after, she had again a fancy for a *koko*, and again her husband went, with a servant, into the forest. As he could not find a *koko* in his own district, he went into that of Matuku. Here Matuku surprised them, slew Wahieroa, and took the servant with him as a prisoner. Some time after this event a child was born, who was named Rata.

5. *Rata.*

When Rata grew up, he asked his mother: "What has become of my father?" "He has been murdered," said the mother. "Who murdered him?" asked Rata. "Matuku did," said the mother. Before you were born I had a fancy to eat a *koko*, and your father went into Matuku's forest, and there Matuku murdered him." "Where is Matuku now?" asked Rata. "Look where the sun rises out of the sea: there, in that direction. It is far away; you cannot yet get there," said the mother.

Some time after this conversation, the mother went into the forest to find a tree that could be made into a canoe. She found a large totara tree which would answer the purpose. A branch of this she took home with her, and in the evening she spake thus to her son: "I have been in the wood, and found

a tree for you, a large totara tree, that can be made into a good canoe. Here is a branch of it. To-morrow you go and have a look at it."

Next day Rata went, and when he came back in the evening he told his mother that he could not find the tree. But she told him to try again: "You cannot miss it," she added, it is a large tree, with a rough bark." Next day he went again, but came back in the evening without having found the tree. However, the mother encouraged him not to be disheartened at first failures, but to try again. The next day he found the tree, and felt more happy in the evening when he came home. He asked his mother how he should go to work. "There are the axes of your ancestors," she said. Rata looked at them, and then said: "But they are blunt." "There is the grindstone of your ancestors," said the mother. Then Rata set to work, and the old grindstone made a noise which seemed to say: "*Kia koi, kia koi!* (to be sharp, to be sharp).

Next day, when the axes had been sharpened and tied to handles, Rata went into the forest and set to work to cut down his tree. At last it fell; and then, when he had chopped off the top it was evening, and he went home, well satisfied with his day's work. Next morning he went again, with the intention of working and shaping his tree into a canoe; but, to his great astonishment, he found his tree standing upright again, as if it never had been cut down. However, he would not be beaten, so he went through the same work again as the day before; cut the tree down, chopped off the top, and then went home, telling his mother of his strange experience. "Did you not invoke the spirits of your ancestors before you went to work?" she asked. "No," said Rata, "I do not know how to do that." However his mother encouraged him not to give up. Next morning he found his tree standing up again, as he had half expected, and he cut it down again and chopped off the top the third time. But now he did not go home, but hid himself under thick bushes near by. He had not sat long in his hiding place, when, in the waning twilight, in the solemn solitude of the forest, he heard a mysterious noise, like voices, by which his own name was mentioned. That noise glided into a singing tune; and then he heard distinctly the following incantation:—

O Rata! O Rata! Wahieroa's son!
Thou fellest, thou fellest, uninitiated,
In Tane's sacred grove,
Tane's flourishing tree.
Now fly the chips to the stump,
Now fly the chips to the top:
So they close; so they fit;
So the branches spread.
Now take hold, and up with him!

Then the whole tree rose, and stood up again. Now Rata came forth from his hiding place, and just caught a glimpse of the spirits, who, shrinking together into themselves, vanished. Then Rata said: "So they have done with my tree; so they have undone my work, and I have been made a fool of." Then a spirit's voice spoke to him saying: "Go home; leave the work for us, thine ancestors; we will finish the canoe." So Rata went home and told his mother what had happened. Next morning, when they got up they found the new canoe quite finished, standing at the side of their house. Then there followed religious ceremonies, to free the canoe from the spirits, so that it could be put to common use. It was named "Niwaru." When all was ready the canoe was launched and manned, and Rata went out on his first war expedition. But little of this is known or remembered, and that little seems more to have been a fight with rats than with human beings. However, *kiore-roa* (long rat,) and *kiore-poto* (short rat,) may have been proper names. They came back victors, but the mother declared that Wahieroa's death was not avenged so long as Matuku lived.

After this, Rata sailed to Puoronuku and Puororangi (the islands where Matuku lived). He went ashore, and found the former servant of his father, whom Matuku had carried away a prisoner. Rata asked him where Matuku was. "Yonder, in his cave," replied the servant. "I am placed here to attend to the plantation." "Will he not come this way?" asked Rata. "Not yet," said the servant, "he comes in the seventh, or in the eighth month, to perform the ceremony before we begin our thistle-cutting." Rata then requested the servant to show him Matuku's abode. It was a cave. Rata placed a noose over the entrance, and told the servant to stand in the plantation, and keep on calling for Matuku to come out. When all was ready, the servant called, "Matuku, e! come to perform the rites for our thistle-cutting." Matuku answered in his cave, calling: "Thou art mistaken in the seasons of Matuku. In the seventh, in the eighth, months, I come to perform the rites of our thistle-cutting." The servant called again: "Matuku, e! come to perform the rites for our thistle-cutting." Now Matuku got angry. He called out: "Thou weariest the patience of Matuku. Now thou shalt see Matuku coming." But as soon as he put his head through the entrance Rata pulled the rope, and Matuku's head was fastened in the noose. Then Rata killed him with an axe. Now Wahieroa's death was avenged.

Matuku is also the name of the slate-coloured heron.

6. *Tuwhakararo.*

Rata left a son, called Tuwhakararo. Little is known about him here. His wife's name was Apakura. Once he made a voyage, and was slain

—through a love affair with a woman named Hakirimaurea—by the Raeroa (long foreheaded) people.

There is a tale in Sir George Grey's book which seems to be identical with this murder, though it stands in a somewhat different context. It says that Tuwhakararo had a sister, who was married to the son of Poporokewa (*kewa* in this dialect means a whale). Once he went to visit his sister, when his sister-in-law, named Maurea, fell in love with him. But she was already affianced to a man of that tribe. In the evening, the lover of Maurea challenged him to a wrestling match, and was thrown twice by Tuwhakararo, and laughed at by all the people. This made him feel ashamed and vexed, and when Tuwhakararo was putting on his clothes again he threw a handful of sand in his eyes. Then, while Tuwhakararo was rubbing his eyes, his adversary murdered him. Afterwards he was cut up and eaten by all the people in the house, and the bones tied under the roof.

I have taken this passage out of Sir George Grey's book because it not only explains the murder, but shows also that those people were cannibals, whereas the Maori at that time seem not to have been such.

7. *Whakatau.*

Whakatau was the son of Tuwhakararo and Apakura. When the news was brought home that his father had been murdered, and when he heard his mother cry, he resolved to avenge his father's death. He painted one side of his canoe black and the other white, and then sailed for the place of the murderers. When the canoe was seen by the people there, they wondered if it were a large seal or a canoe. Several rushed into the sea and swam toward it. When the first swimmer came near, he called to Reinuiatokia (this seems to have been a brother to Whakatau), who was steering, to turn back. Reinuiatokia told him to pass on. He then swam to the fore part of the canoe, where Whakatau killed him with the blow of an axe. The next swimmer met with the same fate, and so on, till a great many were killed. Only one, called Mongotipi, escaped and returned alive to the shore. He told the people that it was a canoe, that one of the men was Reinuiatokia, but that there was another great man whom he did not know. In the night Whakatau landed alone, and sent a message to his mother by the canoe, to watch at night to see the burning of Tihiomanono. Then he hid himself in the bush and disfigured his body with ashes and charcoal, so that he had the appearance of an old mean man.

Next day there came people into the bush to get firewood. Whakatau, disguised as an old stray slave, joined them, took a bundle of firewood on his back like the others, and went home with them. When they came to the

place the wood-carriers called to the people there: "We have found a slave." In the evening all the people assembled in the large house, Tihiomanono. Whakatau walked in with them and sat down, as an old slave, in whom no one took any interest. The people talked over the affair that had happened the day before; and Whakatau silently surveyed the house, so as to form his plan. While he was doing this, the bones of his father, which were hanging under the roof, began to cry to the son. The people heard the sound in the dry bones, and remarked that they were crying for vengeance, and wondered whom they could mean to be the avenger. Then the conversation turned upon the stranger who had slain so many of them the day before, and they questioned Mongotipi, the man who had returned alive, what sort of man that stranger was. Mongotipi said he could not describe him, he was such an extraordinary man. Some one of the company asked, "Was he like me?" "No, not at all," was the answer, "he was a very different man." "Was he like me?" asked another. "No, not at all; there is no one like him here," said Mongotipi.

"Was he like me?" asked Whakatau, who had by this time rubbed off the ashes and charcoal, and who had now drawn himself up in his natural bearing. Mongotipi looked at him, stared in silent wonder, and then exclaimed: "That is the man!" Now all the people jumped up to rush at him. But Whakatau quickly caught up a vessel with water and poured it over the fires. Now all was confusion and darkness, and while the people were scrambling one over the other Whakatau snatched the bones of his father, rushed with them out of the house, barricaded the door, and then set fire to the house, and burned the people in it.

That night Apakura, Whakatau's mother, was sitting on the top of her house, watching the sky in the direction of Tihiomanono. At last there shot up a red glare, and then she rejoiced that now her son Whakatau was a hero; he had avenged the death of his father.

With Whakatau the line of those ancient heroes ends; at least as far as is known here in the south.

As, at the end of the period of the gods, in Part I., we had a rounded-off tale in the mythical figure of Maui, which, though not connected with the preceding gods, yet partook something of their supernatural mysteries: so likewise here, at the end of the period of the ancient heroes, we have again, in the following, a well rounded-off tale, which, also unconnected with the preceding heroes, represents, like these, the human side of that period.

The northern natives, according to Sir George Grey's book, make the heroine of the following tale to be Maui's sister, whose husband was transformed into a dog by her wicked brother; and who thereupon threw herself

into the sea to drown herself, but was washed up at a distant shore, where she was found by two men, who revived her. But it seems to me that the following tale belongs to a later period than that of the Maui family.

8. *Tinirau and Hine-te-iwaiwa.*

Tinirau was spoken of as the most handsome man of his time; and when his fame reached the ears of Hine-te-iwaiwa she was determined to have him. So she made up her mind to go to the place where he lived. Her heart was already so full of him that, as she went along the sea shore every time she found a fish thrown up by the waves, she sang, "Fish, fish, art not thou a fish thrown here by Tinirau?" When she came to Tinirau's place, and before she was seen by any one, she found his looking-glass wells, where Tinirau used to go to dress and to look at his handsome image in the water. There were three wells, with railings and sheltered seats. She broke all the railings and the shelter.

Now it happened that two servants of Tinirau's house passed by the wells. The name of one servant was Ruru-mahara (remembering, or intelligent owl), and that of the other Ruru-wareware (forgetful, or stupid owl). When they came home, Intelligent Owl said that Tinirau's looking-glass wells were broken. Tinirau, upon hearing this, asked for the particulars. Stupid Owl said, "I saw nothing broken; the wells are all right." "But they are broken," said Intelligent Owl, "I have seen it." "I saw nothing broken," said Stupid Owl. Then Tinirau said he would go and see for himself.

When he came to the place, there stood Hine, by the broken wells. She darted a flash of lightning at him; he darted a flash of lightning at her; and then they fell in love with each other, and sat down together and talked of love. When they had sat awhile, Tinirau said to Hine, "Let us go home." "No," she replied," "let us stay here." "But we have nothing to eat here," said he. Then she chanted—

"Let down, let down! drop down, drop down!"

and there lay a heap of food by their side. Toward evening, when the air began to feel chilly, Tinirau said again, "Let us go home." "No," said she, "let us stay here." But the night is chill, and we have no warm clothes here." Again she chanted—

"Let down, let down! drop down, drop down!"

and there lay a heap of warm clothes by their side.

Tinirau had two wives at home. The name of one was Makai-atua-uriuri, and that of the other Makai-atua-haehae. When Tinirau did not come home, the wives, next day, sent the two servants to look for him. When the

servants came back, the wives asked, "Have you seen him?" "Yes." "Where is he?" "By the wells." "What is he doing there?" "He is not alone," said Intelligent Owl, "there is some one with him." "I saw no one with him," said Stupid Owl, "he was quite alone." "He was not alone," said Intelligent Owl, "there was some one with him." "No, there was no one with him," said Stupid Owl. Then Intelligent Owl said, as if in desperation, "I assure you I saw two heads and four feet." That was enough for the wives; they both got up, each armed with a club, and went to the wells.

When they were seen coming, Tinirau said to Hine, "There come your sisters-in-law; now defend yourself." Hine replied, "If they come with evil intent, I shall be a match for them." Then she caught up a flint in one hand and a club in the other, and stood on her defence. First, one of the wives aimed a blow at her head, but missed, because Hine jumped aside, and at the same time struck her assailant with the club and killed her. Then the other wife struck at her, but missed also, and was at the same time killed by Hine with the flint in her other hand.

Now the two lived happily together for some time. In due time also a child was born. But their happiness was disturbed by a brother of Hine, called Rupe. In former heathen times Maori brothers could sometimes be cruel to their sisters, their love to them being of such a selfish nature that they disregarded their sisters' happiness. But this brother appears here more like a spirit than a brother of flesh and blood. One day Tinirau and Hine with their child were sitting in the pleasant shade, and were very happy, cleaning each others heads, when all at once there came a cloud of thick mist, shaped like a large owl. This misty apparition contracted and became a man, who sat down by them and began to cry, as was the custom when long separated friends met again. In the cry the stranger sobbed:

Rupe—Rupe—the—brother!
Hine—Hine—the—sister!

Then Hine answered in her cry:

That—means me—Hine-te-iwaiwa!

Thereupon the brother snatched up his sister and her baby and hastened away with them. Tinirau cried after him, "O Rupe! bring back our sister;" but that was of no avail.

When Tinirau had somewhat recovered from his surprise and sorrow, he thought of a way to follow his wife and child. He had a large tame fish, which was one of his ancestors, called Tutunui, on which he occasionally took a ride over the sea. his pet seabirds accompanying him on such excursions. Now he went to the sea shore and called for Tutunui, who soon made his

appearance, and Tinirau got on his back and rode away over the sea, his pet birds flying and screaming over him. When they came near an inhabited place, then the birds hovered and screamed over the same, to see if Hine was there; and when they ascertained that she was not, then they flew screaming away to another place, Tinirau following them on the back of his fish, Tutunui.

While so proceeding, he happened to meet an old acquaintance, named Kae, who came paddling along in a small canoe. They both stopped to have a little chat, in which Kae persuaded Tinirau that they should change their conveyances. Then Tinirau stepped into Kae's canoe, and Kae got on the back of Tinirau's fish. Before they parted, Tinirau charged Kae to get off while still in deep water, and on no account take their ancestor into shallow water. Kae promised that he would do so. Then each pursued his way.

Tinirau paddled away in the small canoe, following his birds. But he found it slow work, and not so easy as riding on his tame fish. Luckily he met another acquaintance, named Tautini, who possessed a large tame Nautilus, which he kindly lent him. On this he could sail nicely by the wind, following his screaming birds. So they went on over the sea, trying many places, over which the birds soared for awhile, circling and screaming, and then flew away to another place. At last they came to a place where the birds would not leave. They kept on flying round and round and screaming always over that place. By this Tinirau knew that his wife must be there, so he let go his Nautilus and went ashore.

When he had gone a little way inland, he met a girl carrying baby's clothes. He asked her, "Where are you going?" "I am going to wash the clothes for my sister's baby," said the girl. "And who is your sister?" asked Tinirau. "My sister's name is Hine-te-iwaiwa, and her baby's father is called Tinirau," she said. "Let me help you to wash the baby's clothes," begged Tinirau. "No," said the girl, "I can do that myself well enough." However, Tinirau begged so hard to let him help her washing the baby's clothes, and to beat them to make them soft, that she at last let him. Then the girl went home with them, leaving Tinirau there by the water.

When the girl came home, she told her sister that she had met a stranger, who had insisted on washing some of the baby's clothes, and that she had let him. Hine asked what sort of man he was, and when the girl described him, she asked for some *karetu* grass, which she wound into a charm, called a *tamatane*; this she gave to the girl and told her to go and throw it at the stranger, and then to come back and tell her if he had caught it or not. The girl did so; and when she came back she told her sister, "I just threw it at him, and he caught it at once." Hine was satisfied.

In the evening she told the girl to go to the common house, to sleep there.

"If they will not let you," she added, "tell them that I sent you because I wished to be alone with my child." So the girl went. But the common people would not let her sleep there, arguing that, as she was the nurse of a sacred child, it was against the rule of the *tapu* that she should sleep in a house among common people. But the girl said, "Hine has told me to sleep here because she wished to be alone. And as for the child being *tapu*, that might be if it had a father; but a child without a father ———." At last she was permitted to stay.

The door of Hine-te-iwaiwa's house was a slab of polished greenstone, and had, therefore, a metallic sound when moved. In the night a noise was heard as of the door being opened. Then some of the common people called out, "Hine! who is there that opens the door of your house?" "I myself," she replied, "I wanted to go out." But it was Tinirau, who had found his wife and child. Next morning she called all the people together, saying "Come and see your brother-in-law." Then there was a great meeting and crying to welcome the stranger, the husband of Hine-te-iwaiwa and father of that wonderful child, that was made so much of by all the people of the place. Now Tinirau abode at that place. It is still the feeling among the Maori—and Europeans who have lived long among them feel it too,—that when there is one child, a descendant of high chieftainship, everyone in the community is concerned about that child.

We must now return to Kae, whom we left riding away over the sea on the back of Tutunui, Tinirau's pet fish. When he came near shore, and the water began to shoal, Tutunui shook his back, intimating to Kae that he must now get off. But Kae, contrary to his promise to Tinirau, kept his seat and urged the fish on toward the shore. When they came into shallow water the fish kept on shaking to get Kae off; but he held on, and drove the fish still further into the shallow water; when at last his gills were filled with sand, and he died. Then Kae cut him up and roasted and ate him.

While Tinirau's mind was occupied with seeking his wife and child he had no time to trouble about his pet fish; but now, since he had found them, and when the crying over the reunion was over, he became uneasy about Tutunui, and what might have become of him. Day after day he sat on the brow of the headland and looked over the sea, and sniffed at every wind, but no sign of his fish would come to him. At last the south wind blew, and then a savoury smell was wafted to him from some distant shore. Then he knew at once that it was the savour of Tutunui, his fish and ancestor, being roasted by Kae. He went home crying, "O! the savour of Tutunui, that the wind is bringing to me!" Then all the women of the place gathered together and assisted Tinirau, crying over the death of his ancestor.

After some days of crying and howling Tinirau felt his mind so far relieved that he could think of vengeance. He wished now to get Kae into his power; and to attain this he persuaded some women to form a band of dancing girls, to go out performing from place to place; and so, when at Kae's place, to get him by subtilty into their power and to bring him over alive. "You can know him," he added, "by a peculiar fastening of his clothes, and by his upper front teeth being broken, which he shows when laughing."

When all had been arranged, the band of the dancing girls, called by courtesy Tinirau's sisters, sailed in a canoe over the sea, following the pet sea-birds as their guides. When they came to a settlement they performed there for the night, and then continued their voyage next day. So they went on from place to place. At last they came to Kae's settlement, over which the birds kept up a long and continuous screaming. The girls landed, and arrangement was made for their play. Kae was sitting by the middle post in the large house, in which the performance was to be given. His appearance answered the description given them by Tinirau; still the girls wished to be sure to get the right man, and therefore tried to make him laugh. But Kae seemed to be wary; he kept his face bent down, and his mouth shut. The dancing went on and the spectators laughed; but Kae did not laugh. Wilder and wilder went the dancing, louder and louder rang the applause and the laughter of the spectators, till at last Kae too laughed and thereby showed his teeth. Then the girls saw that his upper teeth were broken and they were satisfied that he was the man. By and by the play ceased, the house was hushed, and all the people, Kae among them, fell into a deep sleep, through a charm laid on them by the dancing girls. But these kept awake. They went outside to arrange the net in which Kae was to be carried away, and to perform the enchantments so that he could not wake up.

When all was ready, they went again into the house, lifted Kae gently into the net, and carried him to the canoe, and then started for home. They landed about day-break and informed Tinirau that they had got him. Now all the people came together to look at Kae, who was still fast asleep. Then Tinirau made him wake up. At first Kae believed that he was still at his own home and that Tinirau, with his people, had taken the place by surprise; but Tinirau bade him to look round and see if that was his own place. No, it was not; he found himself a prisoner. Then Tinirau began to kill him, and Kae howled. "Ah," said Tinirau, "Tutunui also cried for his skin, when you had no pity upon him." So Kae was killed, as a satisfaction for Tutunui.

After Kae had been killed Tinirau lived an easy, lazy life. This made the people grumble. It seems they were willing enough to work for Hine and her wonderful child; but they did not think that Tinirau, who was a stranger

to the place, was entitled to such a consideration. One evening, when Hine, with some other women, was sitting by the fire, one of them said to her, "Your husband seems to take it very easy; he never goes to work to get food for you." At this casual remark Hine felt sorely offended. She went away, and was afterwards found by her husband, sitting alone and crying. He asked her what the matter was: and she told him that she had been so much hurt by having heard the people grumbling about him that he never worked to get food for her. "O," said he, "do not take it so seriously; we will satisfy them."

That evening Tinirau said to Hine, "To-morrow you tell your people to go to the forest and cut down trees, and carry the timber home, and build storehouses and stages for food." Hine did so; and the people obeyed her. The work went on; day after day timber was cut and brought home, and stores and stages were built. The people began to grumble, saying, "Where is the food that is to be stored." Still Hine, at the instigation of her husband, kept them at work, till the grumbling became very bad, when they were told they might leave off and rest.

In the evening Tinirau went to the sea beach, with a new *kauati* (pieces of wood by the friction of which fire is produced), and performed his enchantments till late at night. When the charm was well laid on he went home, and and the sea began to throw out fishes. The first fish fell in the yard of the private house, where the child and its parents lived, but the rest fell on the new stages. That night the people in the common house were still talking about the useless work they had performed in erecting those stages when there was no food to be stored, when they were startled by a strange noise, a continuous bumping on the new built stores, with sounds like live fish kicking with their tails on dry ground. The night was so dark, and the noise so awful, that no one ventured to go out. By and by there was a crash of a store breaking down under the weight of the fish; still the bumping and kicking went on, even close before their door, and then there was another crash and break down of a *whata* or store. So a fearful night was passed. With the breaking of the day the sounds had ceased; and when the people opened the door, there was a sight! Fish and broken down stores were mixed into a huge heap. There was no road for the people, they had to climb over the heap of a confusion of fish and broken timber.

But the yard of the child's house was clear. There was only one fish, the first one, lying before the door of the house.

KO NGA KORERO TAWHITO A NGA TOHUNGA MAORI O MURIHIKU; HE MEA KOHIKOHI NA REV. J. F. H. WOHLERS.

THIS paper is a copy of the Maori Mythology in the same words as dictated to me by some old Maori wise men; out of which text I translated the paper into English, which has been read before the Otago Institute. In that paper I left out several names and passages in which I could not find a meaning, but they are all here in the Maori text. The language is in the Murihiku dialect, but in the pronunciation I have mostly kept to the general Maori orthography, because that is better for the understanding of the meaning of the words.

I must also mention here that about the time I was collecting the tales I sent a few specimens of the same to Sir George Grey, and that part of them have been printed in his book in the Maori language. I only mention this, because some, when they see a few passages in that book and in this paper exactly alike, might think I had copied them. It will be also observed that in Sir George Grey's book those few passages which are alike are in the Murihiku dialect. All that is here has been collected by myself here in the south.

The old Maori tales, as originally collected by me—written down word by word out of the mouths of several old Maori—are bulky, incoherent and rambling, and few readers would have the patience to wade through them. I undertook the labour of collecting and studying them chiefly for the purpose to learn the Maori language and way of thinking. In the following Maori text I have tried to order the narration, and have left out tiresome and useless repetitions, but have retained the essential passages and expressions of the untutored old Maori, as spoken in this dialect, even if the grammar does not seem what it ought to be. This is, I presume, what the Society wishes, namely, a Maori text by the old Maori, and not a modernised Pakeha-Maori text. I have still several old tales which would form a third part.

1. *Tangaroa.*

I noho a Tangaroa i a Papatuanuku.—Ka haere a Tangaroa ki waho, ki te Kahuipuakiaki, ki nga taonga o Whakitau. Ko hoki tera, hoki rawa mai, kua noho te wahine, a Papatuanuku, i a Rangi. Ka hemo mai a Tangaroa ki te huata; ka hemo mai a Rangi ki te huata. Ka tata mai. Werohia e Rangi ki a Tangaroa, ka ngaro a Tangaroa, ko taha te huata a Rangi. Ka werohia e Tangaroa ki a Rangi, ka whiti te tao te papa o te iramutu, tana rua o nga papa: takoto tou a Rangi. Ka tukua te wahine ki a Rangi.

Inaianei, ka kitea te atua nira, e tu ana i runga o te ngaru o te moana. Ko Tangaroa tena.

2. *Ko Tutakahinahina.—Ko Te Roiroiwhenua.*

He tangata; haere noa tenei tangata i runga i te mata o nga wai: ko Tutakahinahina te ingoa o tenei tangata. Kahore ia ana matua. Ka noho ia taua tangata i te wahine, ko Kaihere te ingoa o tenei wahine. Ka puta ki waho tana tama, ko Te Roiroiwhenua te ingoa o tenei tamaiti.

Ka mate a Tutakahinahina, ka korero ia, kia mahi nga tangata; kia mahia he kai, kia mahia he wahie. Ka mahi nga tangata; ka mauiui, ka noho. Ka mahi te Roiroiwhenua; ka mahi ona tia. Ka tae ki te rangi i mate ai tona tupuna, a Tutakahinahina, ka mutu tana mahi. Ka mate tona matua, ka tapuketia ki te tara o te whare, taepatia. Ka hurihia tona aroaro ki raro, tona tuara ki runga.

Katahi ka puritia te ra e Kumeateao, e Kumeatepo, e Unumiatekore. Ka kutia nga po, kahore ia kia marama. No reira i pouri ai te rangi me te whenua me te moana. Ka noho nga tangata i roto i te pouri. Kahore e kitea te huanui ki te kai, te huanui ki te wahie. Ka noho tonu nga tangata i roto i o ratou whare; ka kai i a ratou kai, ka tahu i a ratou wahie; ka tahu i a ratou takitaki, ka tahu i a ratou poupou. Ka mahiti o ratou kai, ka mahiti o ratou wahie; ka mate nga tangata. Ka ora, ko te Roiroiwhenua, ka ora ona teina ka ora ona tangata.

Ka mahiti nga wahie a Te Roiroiwhenua, ka tahuna tona paiatara tapu. Katahi ka rongona te korero a tona matua. "I konei i mate au, tapuketia ahau, ki te tara o te whare, taepatia. I konei, kia aro mai koe, tirohia ki te rewanga ki runga o te oneone." Ka whakarongo atu a Te Roiroiwhenua e ngau ana i te tuataata. Ka puta nga iro o Tutakahinahina ki reinga, ka tirohia, e haere ana i roto i te taepa, erua, ko te uwha, ko te toa—no te hinu o tona hakoro. Ka kohia ki tona ringa. Ka karanga ia ki nga tangata i roto i te pouritanga. Ka hikaina ki te ahi; ka tu, ka tawhiri, ka mura. Ka tahuna te Oumu. Ka taona te toa, ko te uwha i waiho.

Ka tae mai a Tamatea-mai-tawhiti, i muhu mai i te po. I roto ano ratou e noho ana i te Nukutaiki, i te Nukuterea, i te Nukumuruaitu. No te tukinga a Tamatea i te oumu ka tae mai te ohanga ki raro. Ka tu te ata matua, ka haea te ata, ka hapara: ko te ata nui. Na ka tangi te umere: He awatea. No mua te waha a nga manu i karanga ai, no muri te waha a nga tangata. Ka marama te rangi, ka marama te whenua, te moana. Ka kitea nga tangata. e takoto ana i reira, i a Hakorotu, i a Hatatai, i a Tanenuiarangi. I reira e takoto ana te kaueti i whakakitea ai te ahi. Ko te ingoa o tenei ahi, ko Tioi, ko te ahi i taona ai nga iro o te hakoro. Ka puta te ra, ka rewa ki runga, ka tu Tokinui-a-Rehua. Ko Tangaroa ia Te Roiroiwhenua.

Ki tu etahi ki: I a Tangaroa te ata i mua; no te kutunga i a Tutakahinahina, i a Tamatea te ata.

3. *Ko Rangi raua ko Papatuanuku.*

I noho a Rangi i tona wahine, i a Papatuanuku. I te takoto mate a Rangi; kua tu i a Tangaroa. Ka puta ki waho nga tamariki a Rangi raua ka Papatuanuku: Ko Tane-kupapaeo, ko Tane-mimiwhare, ko Tane-nakatou, ko Tane-waroro, ko Tane-hupeke, ko Tane-tuturi, ko Tane-tewaiora, ko Tane-tematatu, ko Tane-tutaka; takoto tou tenei tutanga. Ka puta ki waho: Ko Tane-nuiarangi, ko Paiao, ko Tawhirimatea; ko te tatanga tenei i whakatika ki runga.

I roto i te pouritanga e noho ana aua tamariki. Kahore he wahi ma te maramatanga e whiti mai ai, kahore he wahi ma te hau e tangi ai. Takoto tou a Rangi, piri tonu ki te whenua. Ka korero nga tamariki, kia patua a ratou hakoro, kia whai wahi ai ma ratou. Kiia e Paiao, kia wahatia ki runga, tu ai. Kiia mai e Tane, "Ekore e taea; kahore he tangata." Kiia mai e Tawhirimatea: "Me waiho marie." Tare tonu a Paiao, kia wahatia a Rangi ki runga. Ka ki atu a Tane: "Wahatia." Kahore hoki kia taea. Kawhakamatau a Tane; kahore hoki kia taea, takoto tou. Ka kiia atu e Tane, ma ratou katoa e hapai. Ka karangatia e Tane: "Ko wai ki runga nei?" Ka kiia iho e tera hanga: "E tu pa whaia!" Ka karangatia e Tane: "Ko wai ki raro nei?" Ka kiia mai e tera hanga: "E tu pa whaia!" Ka karangatia e Tane: "E tu ma totoro! Whakaekea te maunga! E tu ma totoro, whakaekea te maunga kia iheuheu e Tane." Ka tukua e Tane ko tona upoko ki raro, ko ona waewae ki runga; na, ka ekea a Rangi ki runga, e aue ana. Ka tokoa ki runga e Tane, mau ai.

Na, ka hoki iho nga kai waho. Ka titiro ake a Tane ki tona matua ki runga: Pouri kerekere haua. Ka haere ia ki Okehu, ko te kura tu ki a Warua. Na, i reira nga kura. Ka mauria mai e Tane, ka tataitia. Ka hoki iho a Tane, ka titiro ake; kahore ano kia pai. Ka haere tera whakahoki ki a Okehu, ka tikina nga whetu, ka tataitia. Ka whakamarokia te ika o te rangi, ka pakaina Panakoteao, ko nga Patari; ka pakaina ko Autahi, ko te whetu o te tau. Ka haere a Tane, ka tae ki te kainga o Tukainanapia, ka tangohia ki a ia nga tupuni o Wehinuwaiamomoa. Tangohia ana mai ko Hirautu, ko Porerinuku, ko Kahuwiwhetu, ko Poaka (Orion) ko Takurua, ko Whakarepukarehu, ko Kuakimotumotu, ko Tahuweruweru, ko Whero, ko Whero-iteninihi, ko Whero-tekokoto, ko Whero-iteao-maori,—ka tae ki te raumati. Na, ka hoki iho a Tane ki raro. Ka titiro ake ki tona matua: Katahi ano kua tau.

Na ka mahara tera, a Tane, kahore ano te whakatau mo tenei matua, mo Papatuanuku. Ka whakaarahia e Tane ana hua hei whakatau i tenei matua, ko nga rakau. Ka parea, ko nga upoko ki runga, ko nga waewae ki raro. Ka peke mai tera, ka titiro;—titiro atu: kahore hoki kia tau. Ka tikina,

turakina ki raro. Ka parea, ko te upoko ki raro, ko nga waewae parea ki runga. Ka poke mai tera ki tahaki, ka titiro atu: Katahi ano ka tau.

Ka tonoa e Rangi a te Aki, a Watui ki waho, ki te whakarongo. Rokohina atu nga hua o te papa, o te inaho, o te maru: whakawarea tonu, kai ai. Ka tonoa a Uru raua ko Kakana ki runga; rokohina atu nga hua o te puarakau: kai tonu, kahore hoki kia hoki mai. Tamo tonu atu.

He Tangi na Rangi.

"Ko Rangi ko Papa, e takoto nei;
Tamairetoro, tamairetoro, taua ka wehea.
Ko Ari ko Hua, e takoto nei;
Tamairetoro, tamairetoro, taua ka wehea.
Ko Tamaku ko Tamaiwaho, e takoto nei;
Tamairetoro, tamairetoro, taua ka wehea,
Ko Rehua ko Tamarautu, e takoto nei;
Tamairetoro, tamairetoro, taua ka wehea."

Ahakoa, kei te noho ke atu a Rangi i tana wahine, i a Papatuanuku, kei te mihi tonu te aroha o te wahine ki tana tane: koia te kohu o nga maunga e rere ana ki runga. Ka ringitia hoki nga roimata a Rangi ki runga ki a Papatuanuku, koia te hauku.

4. *Ko Tane.*

Ka mutu te mahi a Tane ki ona matua, ka haere, ka porangia he wahine mahana. Ka porangi ki nga maunga ki nga wai matatiki, ki nga rakau, ki nga manu: kahore hoki i kitea he wahine mahana. Ka tahuri mai ki tona hakui, ki a Papatuanuku. Ka ki atu te hakui: "Hoki atu. Nahaku hoki koe. Nai te wahine mahau; whakaahua i te oneone." Na, ka haere a Tane, whakaahua i te oneone, he wahine mahana. Ko Hinehaone te ingoa o taua wahine. Ka noho i a Tane, ka whanau he tamahine, ko Hineatauira te ingoa o tenei tamahine. A, ka tupu, ka kaumatua, ka noho i a Tane, he wahine mahana. Kohore ia i matou, ko tona hakoro ia. Kua ngaro noa atu tona hakui. Ka noho raua, ka whanau ki waho: ko Tahukumea, ko Tahuwhakairo, ko Tahuotiatu, ko Tahukumeatepo, ko Tahukumeateao.

Muringa ra ka haere a Tane, ka porangi ki a Rehua, ki te tuakana. Ka tae tera ki tetahi kainga i runga nei, ka ki atu tera: "Kahore he tangata i runga nei?" Ka ki mai nga tangata o taua kainga: "He tangata ano i runga nei." "Ekore ranei au e tae?" "Ekore koe e tae; ko te rangi tenei i kumea e Tane?" Na, ka wahi ake a Tane, noho ana i runga i tera rangi. Ka haere ake, ka tae ki tetahi kainga ake, ka karanga atu: "He tangata ano i runga nei?" He tangata ano. "Ekore ranei au e tae." "Ekore koe e tae; ko te rangi tenei i tuhia e Tane." Ka wahi ake, ki tera rangi. Ka tae atu ki tetahi kainga, ka karanga ake: "He tangata ano i runga nei?" "He

tangata ano." "Ekore ranei au e tae?" Ekore koe e tae; ko te rangi tenei i rohea e Tane." A—whenei tonu tae rawa ki te ngahuru o nga rangi.

Na, ka tae ki te kainga a Rehua. Ka haere mai tana tuakana kia tangi raua. Ka tangi makuare a Rehua; na Tane te tangi karakia:—

"Tipia, tahia, ngakia, rakea;
Tipia te rangi kia rahirahi,
Toto mai i waho.
Wariki o te rangi
Auaha tou ingoa,
Ko te rangi puaiho,
Turuturu o te rangi;
Kia mau ai, ko Tane anake,
Na na i tokotoko te rangi tou."

No te mutunga o te tangi ka matau a Rehua, ko Tane tenei. Ka ki atu a Rehua ki ona tangata, kia tahuna he ahi. Ka ka te ahi. Ka ho mai he ipu. Ka mahara a Tane, keiwhea ranei nga kai ma enei ipu i ho mai nei? Ka tirohia atu e wetea ane e Rehua te upoko—i herea te upoko. Wetea ana, ka ruia ki nga ipu—he koko e kai ana i nga kutu o upoko o Rehua. Ka ki nga ipu i nga koko, ka mauria ki te ahi, ka kohua. Ka maoka, ka mauria mai ki te aroaro o Tane. Ka kiia mai e te tuakana kia kai. Ka kiia atu e tera e Tane: "Ekore au e kai. Titiro rawa ahau, e wetea ano mai i roto i tou upoko. Ma wai hoki te kai, i kai ai i nga kutu o tou upoko." Ne reira i mataku a Tane, ki te tuakana.

Te kiinga atu a Tane ki a Rehua: "Ekore ranei e haere i au." Kiia mai e Rehua: "E haere i a koe. Ka hua te rakau, na, rere atu te manu, ka tau ki reira kai ai." "Me aha?" Ki te mea ka tangi te hau, ka maroke te kaki o te mano, ka tae ki te wai: me ta ki te kaha.

Ka tae atu a Tane ki te kainga a Nukuroa raua ko Tamatea-kaiwhakapua. Ko nga wahine anake i rokohina atu; ko nga tane kua riro ki te whai kiore. Tokorua nga wahine. Ko tahi te wahine i noho, kotahi te wahine i whakapekapeka. Na ka mea kai ma Tane; he kiore te kai. Kahore ia i kai. Kiia atu e ia: "Ko te kai tenei a o korua nei tane?" Ka ki mai nga wahine: "Ae." Ka kiia atu e Tane: "Me waiho tenei kai ma a korua ariki, ma Te Tupuao raua ko Hinekitaharangi."—Na ka kiia atu e Tane, kia haere raua ki a raua tane. A, ka haere aua wahine. Rokohina atu e noho ana nga tane. Na ka korero atu: "Kua noho maua ki te tane. Ko tenei toku noa i whakapekapeka, ko au ia i anga atu." Ka ki mai te tane nahana te wahine i whakapekapeka: "He aha koe i whakapekapeka, te tahuri atu?" A ka kiia mai e nga tane: "Haere ki to korua manuwhiri, apopo maua whana atu.

Na te ata haere mai nga tane ki te kainga, ka ho mai i te mataahi ki a

Tane. Kahore a Tane kia hiahia atu ki taua mataahi—he mea kiore e kai ana i nga tutai, e ketu ana i a raua paruparu. Kahore kia kainga e Tane; i mataku i reira; na te tangata i mua.

Na ka hoki mai a Tane, ka Tae mai ki te kainga o tona hakui. Na, kahore tana wahine i reira. I runga ano i te kainga o Rehua a Tane, ka ui atu a Hineatauira ki tona hungoi, ki a Papatuanuku: "Keiwhea toku nei tane?" Kiia mai e te hungoi: "E, ko tou tane! Ko tou hakoro ra pea." Katahi ka rongo a Hineatauira he tamahine ia na Tane, ka mate i te whakama. Ka poroporoaki ki tona hungoi, kiia, kia noho a Tane i te ao, hei whakatupu i a raua nei hua; ka haere tera ki te po, hei kukume i a raua nei hua. Na, ka hoki mai a Tane ka ui atu ki a Papatuanuku: "Keiwhea toku nei wahine?" Ki mai te hakui: "Kahore ia wahine mahau. Kua riro ia, kua heke. Kiia iho koe, kia noho i te ao hei whakatupu i a korua hua."

Ka haere a Tane ki te whai atu i tana wahine, i a Hineatauira. Na mahana ka tae atu ki raro, ki te po; kopikopiko noa atu. Mana ka tae ki te whare, ka ui atu ki te poupou o te whare. Kahore hoki he waha kia ki mai. Ka ui atu ki te maihi o te whare; kahore hoki he waha kia ki mai. Ka mate tera i te whakama, ka nunumi, ka tawhe ki te tara o te whare.—Na ka ui mai te tangata o te whare: "E haere ana koe, e Tane, ki whea?" Ka kiia atu e Tane: "E whai atu ana ahau ki ta taua tuahine." Ka ki mai te tangata o te whare:

"E hoki, e Tane, ki te ao,
Hei whakatupu mai i a taua hua.
Tukua tonu au ki te Po
Hei kukume i a taua hua nei."

5. *Ko Maui.*

Na Mahuika a Hina, te hakui. Ka noho ra i a Te Raka. Ka puta ko Maui-imua, ko Maui-iwaho, ko Maui-iroto, ko Maui-itaha, ko Maui-potiki. He maro; ka panga ki runga ki te tataraheke. Ka haere mai a Mu, a Weka; ka rokohina mai e takoto ana. Ka mauria, takaia ki te hukahuka; ka whakatupu ki reira: ka tupu he tangata.

Ka rongona e Aonui, e Aoroa, e Aopouri, e Aohekere; ka tikina mai. Ka mauria ki runga ki te rangi, ka noho. Ka mate i reira Te Roiroiwhenua, Te Rakowhenua; ko te patunga tuatahi tenei a Maui. Ka noho a Maui i a Kaitatuwhainga raua ko Maruitewhareaitu. Ka tukua e maui ki te huka te mahinga kai a Maruitewhareaitu kia mate. Ka pirau katoa nga kura, ka takua e Maru ki te toroku kia mate ta Maui mahinga kai. Ka mate, kahore hoki i tupu. Ka mahara a Maui; ka tawhangatia a Maru e haere mai ana, ko nga maori nei ko nga taru nei, mauria ki te ringaringa. Ka tae mai

ki te taumatua, ka patua e Maui. Ka mate a Maruite whareaitu. Kahore hoki i tae kia karakiatia.

Ka tonoa a Maui ki te kainga a ona matua. Ka tae mai ki te kainga, rokohina mai e kokiri ana nga tuakana. Ka kokiri hoki a Maui, paku atu ai, ka tu ki te maihi o te whare o Raka raua ko Hina. Ka puta ki waho te wahine, ka ui: "Na wai ka pae nei te maihi o te whare?" Ka ki atu nga tuakana: "Na ra, te tamaiti nei." Ka ui atu te hakui: "Na wai ra te tamaiti?" Ka ki mai a Maui: "Nahau ano." Ka ki atu te hakui: "Kahore hoki. Ka mutu ano nga tamariki ahaku, ko ena." Ka ki atu a Maui: "Aua ra, nahau ano ahau. Ko tou maro, i panga ra ki runga ki te tatareheke. Na aku tupuna ano ahau i whakatupu. Nahau ano awau. Ko Maui ahau, te marorakerake." Katahi ano te hakui ka mahara, ae, nahana ano.

Ka noho a Maui i te kainga o te hakui, ka mahara; keiwhea ra toku hakoro. Ka ahiahi te ra, ka tu waenganui te po, ka oho ake a Maui, ka rongo e korero ana te hakui raua ko te hakoro. Ka kainamu ki te ata, kua ngaro a Te Raka. Ka ahiahi, ka po, ka moe whakakiko a Maui. Ka tae mai a Te Raka, ka wewete i te maro, ka ho atu ki tahaki, a—warea atu i te moe. Ka tikina atu e Maui taua maro, ka huna ki raro i tona moenga. A, ka oho ake a Te Raka, ka porangi i te maro, kahore hoki kia kitea. Ka awatea. Ka unuhia te poupou, ka ngaro a Te Raka. I te ata, ka hori te hakui ki te ahi kai, ka whaia e Maui te poupou, ka titiro ia ki raro. Ka kitea, ae, tenei ano te huanui. Ka whakahokia te poupou, hunakia.

Ka haere nga tuakana ki te ta kereru. Ka haere hoki a Maui. Ka karanga atu ki te hakui, kia ho mai ki a ia he hinu, kia homai hoki he mea tuhi. Ka tae mai ka haere. Ka tae atu ki ro o ngaherehere. Ka pani a Maui ki a ia ki te hinu; ka tuhi ki nga ngutu, ka tuhi ki te rae, ka tuhi ki nga waewae: ka whakatauria e ia ki te kereru. Ka pakaina te maro o tona hakoro ki te kaki. Kahore nga kereru kia mataku ki a ia; hopukina toutia e ia. Ka ahiahi te ra ka haere ki te kainga,me tana kawenga kereru. He mea tu ra a nga tuakana, he hopu tou ahana. Ka manawareka te hakui. I te po ka toe mai a Te Raka. Ka rongona e Maui te korero a te hakui: "Ta taua tamaiti i whakamate te kai! He turanga a nga tuakana, he hopu tou ahana." Ka moe ratou. I te po ana ka riro a Te Raka ki raro.

Ka whakaaro a Maui kia haere kia matakitaki i te huanui a te hakoro. Ka unuhia te poupou, ka ngaro ki raro. Ka haere ra taua huanui. Ka tae ki te wahi wanui. Ka whakatau ki te kereru ka rere. Ka kitea etahi tangata i waenga e mahi ana. Ka rere te kereru, takamio rere, a, ka noho ki runga ki tetahi rakau hakahaka. Ka kitea e nga tangata o raro, ka karanga atu tetahi: "To tatou kereru!" Ka whana atu te kai pihere, ka rere te kereru; ka whana atu hoki te kai pihere, ka rere te kereru. Kua kitea hoki

te hakoro. Ka rere mai te kereru ki runga ki te hukui o te ko a Te Raka. E ko ana a Te Raka i waenga. Tangi ana te kereru i runga i te hukui o te ko. Na titiro ana te hakoro, ki ake nei: "Ko te tangata pea o runga na?" Ka kuiho ai ki te hakoro. Ka whakaeke ki raro ki te whenua. Na, kua whakatangata. I rokohina atu te hakoro e ko makuare ana. Na Maui i ho atu te peha.

"Koia ko Tararauriki.
Ki mai Maui ka hara ki te whitu.
Tukua te taupiri, tataia te orarangi.
E tau, ei.
Koia manutireia
Manu wherohia ki te poho a Raka.
Ka taurere, ka tau whakaeke,
Ka tau mai i te ruhi."

Ka mutu, ka mahara a Te Raka, koia ko Maui. Ka arahina ki te kainga.

Kua mate te ahi. I a Mahuika te ahi. He taua a Mahuika, he tupuna na Maui, na te taha o te hakui. Ka taringa te kai tiki ahi. Ka ki atu a Maui, mahana e tiki. Ka haere ia, ka tae atu ki te kainga i a Mahuika. Ka ki mai taua wahine ra: "Na wai i ho mai ki konei? Na te hau i pa mai ki Toku kiri?" A, ka rongo, ko Maui tenei, ka tangi: "E, ko toku mokopuna!" Na, ka ho mai he ahi. Hoki tou mai a Maui, ka tinei, ka mate te ahi. Hoki tou atu ki taua taua ano, ki te tiki ahi; a, ka tinei hoki. Mahiti katoa mai nga ringaringa me nga waewae a Mahuika. Ka tae ki te koiti, ka ki atu taua wahine ra: "Ehara koe i te tangata i raro nei; ko te tangata ano koe o runga nei, o runga nei." Ka riri taua taua ra, ka tahu i tana ahi, kia wera ai a Maui i te ahi. Na, peo ana mai a Maui, kua whakakahu. Ka tahu a Mahuika i tana ahi, ka rere a Maui ki runga, ka tukua iho he kohu. Ka tungutu a Mahuika i tana ahi; ka tukua iho e Maui he awha puroro. Ka tungutu a Mahuika i tana ahi; ka tukua iho e Maui he awha rarahi te pata. Ka tungutungu a Mahuika i tana ahi, ka tukua iho e Maui te huka kapo, ka uruhia papakia te huka. Ka mea kia mate te ahi, ka pakaina e Mahuika ki te rakau, ki roto ki te kaikomaka, ka pakaina ki roto ki te putaweta; kahore hoki kia u. Ka pakaina ki te totara, ka u, ka pakaina ki te tumatakura, ka u. Ka pakaina ki te hinahina, na, toro tou.

Ka rere iho a Maui; kua whakatangata ia. Ka hoki mai ano ki te kainga o te hakui. I reira ano nga tuakana. I reira hoki tetahi tupuna o Maui, e noho ana, ko Murirakawhenua te ingoa o taua poua. A, ka maoka nga kai ka haere nga tuakana, ka kawe kai mo to ratou tupuna. Ka taringa te kai kawe o nga kai; ka ki atu a Maui, mahana e kawe. Ka whana atu, kai rawa; ko nga rourou waiho i nga tara o te whare, takoto ai. Muringa ra ka toro a Maui ki roto ki te whare o tona tupuna: rokohina atu a Murirakawhenua e

takoto ana; kua mate. Ko tetahi taha ake e ora ana; ko tetahi taha kua pirau. Ka whai atu a Maui, ka ihi te kauae o Murirakawhenua. Ka kawea ki te wai, ka taia, ka rorokia, ka kawea ki te moana: he rua te ika nana i piki te kauae o Murirakawhenua. Ka huna ki roto ki a ia hei maka.

I te po ano nga tuakana ka haere ki te moana—he mataku ki a Maui. Ka oho ake tera, kua riro. A, ka noho tera. I te po ano ka haere a Maui; rokohina atu e takoto ana te waka. Ka haere ia ki te tauihu o te waka, ka whaia atu te kete tahunga, ka tomo atu ki roto, ka takoto ia. Ka kainamu ki te ata ka haere mai nga tuakana. Ka tae mai ki te waka, ka tirotiro—a, kahore tahi nei. Ka toia te waka ki te moana; ka hoe, ka tae ki waho ki te moana, ki runga ki te turanga. Ka mounu nga tuakana, pakia mai taua kete tahunga ra: ka puta mai ki waho a Maui, noho ai. Ka karanga atu nga tuakana, kia whakahokia ki uta. Ka ki atu nga tuakana atawhai, kia waiho ki runga ki te waka. Ka ki atu ano nga tuakana atawhai kino, kia whakahokia ki uta. Ka ki ano nga tuakana atawhai: "Waiho ano i konei noho ai. He maka hoki, u ana, kauraka e ho atu." Na, ka mea nga tuakana kia tukua nga maka. Ka ki atu tera, a Maui: "Ho mai mahaku tetahi maka me tetahi mounu." Ka ki atu nga tuakana: "Kauraka hoki." Na, ka mea kia tukua nga aho o nga tuakana, ka motokia tona ihu e Maui; taratia ana te toto. Ka rere, ka tarati te karukaru, ka potaea ki runga ki tona maka hei mounu. Ko te kauae o tona tupuna te maka i a Maui. Ka tukua ki ro o te wai. Na, i taua tukunga tae rawa te timu ki te hakui. Karanga atu tera: "Ko Maui, potiki ahaku, kei te whakatane i a ia!" Na kei te kai ano te ika ra; ka hapainga mai ki te ihu o te waka. Ka poa te ika. He karakia ano ta Maui. No te kainga o te ika ka whangainga e tera: "Kai mai e waro warari; e waro wanaka ake." Ka tangi te poa o te ika. Ka karanga atu nga tuakana: Maui, tukua atu taua ika ra." Ka ki atu a Maui: "Ko toku ika ano tenei i tae ai au ki te moana."—"Maui e, tukua atu, he atua tahau." Ka ki atu a Maui: "Ko taua ika ano i tae ai au ki te moana." Ka kumea ki runga, ka tukua; ko te whenua. Tukua rawatia ake, tu ana nga whata, me nga whare; aue ana nga kuri, ka ana nga ahi, noho ana nga tangata, korero ana, haere ana. Ka korokoroko te ika i hiia e Maui, ka ea, ka whaka whenua, ko te ika a Maui.—Ka hoki a Maui ki to ratou kainga ko nga tuakana.

Ka noho a Maui ki te wahine, ko Hina te ingoa, he tamahine no Tuna raua ko Repo. Ka haere a Hina ki te wai. Ko te taunga ano ki te wai, ka puta mai a Tuna; ka korepekia te hiku, maua nga para.—Ka haere atu a Hina, ka korero atu: "Tangata nei! E whakapai tangata nei! Maenene ana te kiri te panga atu nei!" Ka mahara a Maui; Me aha ra? Me keria te awa. A, ka keri a Maui ki te awa, a, ka honu, ka ki atu tera ki te wahine, kia haere raua. Ka tae raua ki te awa, ka ki atu a Maui, kia haere ki te taunga noho

ai; ko Maui ki te tauaaha. Ka whaihangatia te patatari, ka whakatokia e Maui ki nga roko.

"Ko te roko patahi, ko te roko parua,
Ko te roko patoro, ko te roko pa wha,
Ko te roko pa rima, ko te roko pa ono,
Ko te roko pa whitu, ko te roko pa waru,
Ko te roko pa iwa, ko te roko pa ngahuru."

Ka puta a tuna. Tere tonu nei nga harakeke me nga paki. Ka tata mai, ka heke. Tae rawa ki te wahine ka mea kia hoki. Ka panga e Maui ki te toki. Ka rere te hiku ki te moana, koia te koriro. Ka rere te upoko ki te wai maori, koia te tuna. Ko te roro whero, koia te pukapuka; ko te roro ma, koia te koarere; ko nga huruhuru o te upoko, koia te aka.

Ka mate tera patunga a Maui. Ka noho. Ka ka te oumu a Hina. Ko te kanga anake, kua po te ra; kainga ane te kai i te po. Ka noho tera, a Maui. Ka ao ake i te ata, ka ki atu ki te wahine: "Tahuna he oumu kai." Ko te ka anake, kua po te ra. Mahara tera, a Maui; Me aha? Ka ki atu ki nga tuakana, kia manawa nui, kia hopukina te ra.—A, ka haere ratou ko nga tuakana ki runga ki te rua. Ka whakatakotoria ki te rua o te ra te mahanga. I raro ano te ra, ko te huruhuru ka puta. I raro ano te ra, ko te ihi i puta ake. Ka puta ake te upoko, ka puta ake te kaki. Ka karangatia e Maui, kia kumea te mahanga. Ka noho te mahanga ki te kaki. Ka aue te ra: "Maui, tukua a au." Ka ki atu a Maui: "Me tarie kae e tukua. Ka patua te ra e Maui. Ka aue ano te ra kia tukua." Ka ki atu a Maui: "E tarie, e koe, e tukua, kia maoka te oumu.—Pakipaki Hina i herea ai te ra e Maui, e tu nei." —Katahi ano te ra ka roa. Me he mea i kore a Maui, po tonu te ra.

Ka mate i a Maui tena patunga. Ka noho. Muringa ra ka haere, ka tae ki te kainga o te taokete, ko Irawaru te ingoa o te taokete. Ka taona he kai ma raua. Rua rawa ake a Maui, kua mahiti te kai i a Irawaru. Whenei tonu. Ka noho rava. Ka whiti te ra, ka ki atu a Maui, kia haere raua ki te wahi ke, noho ai. Ka ki atu a Maui: "Hakurea toku upoko." Ka hakurea. Ka mutu, ka ki atu a Maui: "Takoto hoki koe, kia hakurea tou upoko." Ka hakurea e Maui. Ka parangia i te moe a Irawaru. Ka kumea nga taringa, ka kumea te kauae, ka kumea nga ringaringa, ka kumea nga waewae, ka kumea te tikitona hei wairo. Ka oti—takoto, he kuri. Ka haere a Maui ki tahaki, ka moimoitia mai; ka whakatika ki runga taua kuri, whenei me te kuri.—Ka haere a Maui ki te kainga, ka ki mai te tuahine: "Keiwhea tou taokete." Ka ki atu a Maui: "Na, na ano, kei to maua nohoanga."—"He aha koe ekore e tono mai."—"Karangatia." Karanga noa te tuahine, kahore hoki kia haere mai. Ka ki atu a Maui: "Whakamatau ki te moimoi." Ka ki atu te tuahine: "He kuri koa e moimoi ai?" Ka ki atu a

Maui: "Koia, whakamatau." Na, ka whakamoikia. Tiro atu, haere mai ana, he kuri ia. Ka, ki atu te tuahine: "Maui rawahanga. Kahore koe titiro tou taokete." Ka piko, ka tangi. Ka tae mai taua kuri, ka nga ki te wahine, ka tangi noa ki te wahine. Ka tangi te wahine, ki whakamomori.

Ka noho tera, a Maui. Ka ho mai te rongo o Hinenuiotepo (ko Hineatauira tona ingoa i mua, ko Hinetitama hoki tona ingoa). Ka haere a Maui. Ka tae ki te kainga o Hinenuiotepo, ka ki atu a Maui ki nga tuakana: "Kauraka au e kataina. Ka puta au, ka kata koutou." Ka tomokia Maui, ka kata nga tuakana. No te katanga ka kutia, ka mate a Maui.

KO NGA KORERO TAWHITO.

1. *Ko Kaitangata raua ko Whaitiri.*

I noho a Whaitiri i runga i te rangi; he wahine. Ka tae mai te rongo a Kaitangata, i noho ra i raro nei. He Kaitangata!—Kahore, he rongo noa. Na, ka haere mai a Whaitiri, ka tae mai ki te kainga i a Kaitangata. Ka noho mai taua wahine i kona i a Kaitangata.—Na, ka haere a Kaitangata ki te moana, ki te hi ika; ka u mai ki uta. Kahore hoki he ika kia mau i ona maka: kahore he kaniwha hei whitiki i te kauae o te ika. Ka ki atu a Whaitiri i aua maka kia homai, kia kitea e ia. Ka ki atu a Whaitiri: "Ko au maka enei?" Ka ki mai a Kaitangata. "Ae." Ka ki atu tera, a Wahitiri: "Kahore he kaniwha. Na, titiro mai." Ka weraina atu tona tara. Ka mea atu tera, a Kaitangata. "E—." Ka whakariharira atu, ka haere ki waho.

Ka noho taua wahine, ka ta i te korohe. Ka auina ake ka haere a Kaitangata ki te moana. Ka noho te wahine, ka kitea atu e tera, e Whaitiri, te waka a Tupeketi, a Tupeketa, e manu ana mai. Ka haere atu taua wahine ki te wai, ka makere ki roto, ka ruku, ka ea. Ka karanga a Tupeketi: "He tangata ranei, he manu ranei?" Ka ruku. Katahi rawe te kitenga i raro i te waka. Ka tu a Tupeketi ki runga, kia werohia. Ka no ake te koripi, ka haea te puku a Tupeketi, ka taka iho ki roto ki te korohe. Ka oma tetahi ki te ta, ka mea kia werohia a Whaitiri; ka ho ake a Whaitiri i te koripi, ka taka ki raro, ki roto ki te korohe.—Ka kau a Whaitiri ki uta; ka waiho atu nga tangata i reira, i roto i te korohe. Ka ki atu ki te hunga wahine: "Kumea mai ki uta." Ara mai,—he waewae tangata!

Ka ki atu a Whaitiri ki a Kaitangata (kua hoki mai ia i te moana) kia whakaponohia. Ka ki atu a Kaitangata: "Kahore kia matau i au." Ka ki atu a Whaitiri: "Whakaponohia te tangata a ta taua tamaiti," (kua hapu a Whaitiri). Ka ki atu a Kaitangata: "Kahore kia matau i au." A, ka ki atu a Whaitiri: "Aua ra, mahau e whakapono te tangata a ta taua tamaiti; nahau rongo hoki."—Na, ka mea a Whaitiri, mana e whakapono. Ka whaka-

pono a Whaitiri, ka taputere te karakia. Ka oti te karakia, ka kotikotia nga tangata; ka kainga e taua wahine. Ko nga iwi ka whakairia ki runga o te whare.—Ka maroke; ka kaiatia e Kaitangata, hei maka. Ka taia hunatia; ka oti te kaniwha, ka taka ake, ka kawe ki te moana. Ka kai te ika, ka hutia ki runga, he hapuka. Tae rawa mai te pakurutanga ki a Whaitiri. A, na te waka ano ka tomo, te hapuka, ka hoe mai ki uta. Ka unuhia nga hapuka, ka taona ki te umu. Ka maoka, ka kai a Whaitiri i te hapuka.

Muringa ra ka pangia nga kanohi a Whaitiri, ka parewha. Ka noho a Whaitiri. Ka ahiahi te ra, ka moe ai iho. Ka kiia mai e te wahine o raro o te reinga: "Aua ra, te mea ka mate na koe, ko nga iwi a tau patunga kua oti te kawe e tou tane ki te moana; no reira nga hapuka i kai na koe, ka mate na koe."

Ka noho a Whaitiri. A, nui noa atu nga ra ka puta ki waho, ko Hema. A, noho ana a Hema.—A, no tetahi ra ka haere mai nga tangata kia kite i a Kaitangata. I waho o te whare noho ai. Ko Whaitiri ia i noho i roto o te whare. Ka ui atu nga tangata ki a Kaitangata: "E aha ana te wahine e noho i a koe?" Ka ki mai a Kaitangata: "Kei te wahine e noho i au: ko te kiri o tenei wahine, me te hau tonu; ko te ngakau o tenei wahine, me te huka tonu."—Kua rongona e Whaitiri.

Ka riro nga tangata, ka haere mai ki ro o te whare noho ai te tane. Ka ki atu te wahine: "He aha a koutou korero?" Ka ki mai te tane: "He aha koia hoki, he korero noa ano ia." Ka ki atu te wahine: "He aha a koutou korero?" Ka ki mai a Kaitangata: "Ko Whai-tane e ui ana mai ki a koe; koia matou e korero mai nei." E huna ana a Kaitangata. Na, kua rongona atu e taua wahine, e Whaitiri. Ka mate i te whakama. Ka korero a Whaitiri ki a Hema: "Kauraka koe e whana ake; kia konokono ariki, kia tupu ou hua, mana e piki ake nga rangi i a Tamaiwaho."—Na, ka kake a Whaitiri. Ka kapo a Kaitangata ki te weruweru o Whaitiri. Ka kake ake a Whaitiri ki runga, ka tae ki te Putoetoe, ki rara noho ai.

2. *Ko Hema.*

Ka noho a Hema i a Karenuku, he teina no Puku. Ka puta ki waho ko Pupumainono he wahine; ka puta ki waho ko Karihi; ka puta ki waho ko Tawhaki he tane enei. Ka noho a Hema, a—ka po maha atu, ka haere a Hema, ka tae ki te kainga a Paikea ma, a Kewa ma, a Ihupuku ma; ka tae atu i reira ka patua, ka mate a Hema; ko te wahine i rauorangia.—Ka noho nga tamariki. Ka porangi a Karihi raua ko Tawhaki ki o raua matua. Ka haere raua, ka kau i te moana e takoto nei; horo tou i te wai, a, hoki tou mai. Ka ki atu te tuahine: "Iwhea korua." Ka ki mai raua: "I te kau maua, kahore hoki maua kia whiti; hoki tou mai nei." Ka ki atu a Pupumainono: "Me

ui mai korua ki au. Mahaku e hoatu te tikanga ki a korua. Na, whakarongo mai:

"Huruhuru takiritia i raro hara, i te kipo hutu,
Orahaina te moana patoto e takoto nei;
Orahaina te moana waiwaia e takoto nei:
Hiki ka tahi, hiki ka rua, hiki ka toru, hiki ka wha,
Hiki ka rima, hiki ka ono, hiki ka whitu, hiki
Ka wharu, hiki ka iwha, hiki ka ngahuru."

3. *Ko Karihi raua ko Tawhaki.*

Ka haere raua, ka tae ki te kainga a Whaitiri, i te Puotetoetoe, e patihau ana—kua pohe noa ona kanohi. Ka tae mai he tangata ka mate i a ia, hei kai mahana. Ka rokohina atu e Karihi raua ko Tawhaki taua wahine e patihau ana. Na, kei te tatau ia i ana kai: "Ka tahi aku kai, ka rua aku kai, ka toru aku kai, ka wha, ka rima, ka ono, ka whitu, ka wharu, ka iwa, e!—keiwhea te ngahuru?" Kua riro te ngahuru i a Karihi, te kapo. Na, ka tatau ano taua wahine i ana kai; a,—ka tae ki te iwa, kua riro i a Tawhaki. Ka mahara taua taua: "Kewhea aku kai kua riro? Ko wai i mea aku kai nei?" Na ka tatau hoki; kua riro te wharu. Ka mahara te taua nei: "He tangata ano te mea i aku kai nei." Kua riro te whitu. Ka riri taua taua nei, ka patihau. Na, ka pakia e karihi te kanohi a Whaitiri, ka titiro atu te kanohi, ka ki atu a Whaitiri: "Purangi aeho toku mata e Karihi!" Ka pakia e Tawhaki; ka ki atu a Whaitiri: "Purangi aeho toku mata e Tawhaki!"—Na, ka titiro ona kanohi, ka karanga atu: "E, ko oku mokopuna! koia nei ano i mea nei i oku kai! Ko oku mokopuna!" Ka haere ratou ki te whare o Whaitiri korero ai.

Ka noho raua i kona, i te kainga o to raua taua, ka titiro raua, e pu ana nga iwi o nga tangata i patua e Whaitiri. Ka mahara raua, akuanei raua mate ai i te taua nei, e patihau tonu nei. Ka ahiahi te ra, kahore hoki raua kia moe. Kei te patihau tonu. Ka o te ra, ka haere raua ki tatahi; ka rokohina atu te pupu e piri ana ki te pohatu. Ka kohitia te aka o te pupu, ka whakapiri ki o raua kanohi. Ka ki atu tetahi: "Titiro mai ki oku kanohi." Ka titiro mai tera, ki mai: "Ae, kei te moe o roto, ko waho kei te titiro." Ka hoki mai raua ki te kainga. Ahiahi ano te ra ka whakapiri i nga aka ki o raua kanohi, ka moe raua. Ka mea tonu taua taua kia patua raua. Kei te hua kei te moe. Ka titiro; kahore. Ko o raua kanohi a roto kei te moe, ko waho ano kei te titiro. A, ka hua taua taua kei te ara raua; kahore, kei te moe.

Ka ao ake i te ata, ka ki atu raua ki a Whaitiri: "Na wai i ho mai nga kai mahau?" Ka ki mai a Whaitiri: "Na aku mokopuna ano." Ka ki mai: "Keiwhea te ara i ho mai ai he kai mahau?"—"Koia ano tena." Ka ki atu

raua: "Keiwhea te huanui?" Ka ki mai a Whaitiri: "Koia tenei te huanui e takoto nei." Ka haere raua, ka porangi ki taua huanui. He huanui haere ki te wai, he huanui haere ki te wahie, he huanui haere ki te taumatua karakia. Ka hoki mai raua ki te kainga, ka noho. Ka ao ake i te ata ka ui atu raua: "Keiwhea te huanui?" Ka ki mai taua taua: "Tahuri mai ki au. Nai te huanui ma korua, kei au. Nau mai haere korua. E tutaki i a korua e haere mai nei, ka whakarongo atu korua. E korero haere mai nei: ko a tatai wahine a Tangaroa, ko Pakihikanui, ko Pakihihewahewa.—Ka mutu taua tatai wahine a Tangaroa.—Kai ho mai kai mahaku; na, e haere mai i muri na e wahangu mai na: ko Pupumainono, ko Hapainuiamaunga, ko Hinenuiotekawa." Na, ka ki ano a Tawhaki raua ko Karihi: "Keiwhea ano te huanui?" Ka ki mai te taua: "Kei au ano te huanui, kei toku kaki. Whai mai, wetea." Na ka whai atu a Tawhaki raua ko Karihi; kei te kaki a Whaitiri e mau ana. Ka takiritia, i reira e mau ana te taura ki te rangi. Ka ki atu a Whaitiri, kia pepeke raua. Ka moa atu raua, ko Karihi ki mua. A, kei te korero ano a Whaitiri: "Kotahi mana korua e patu, ko nga hau o te Ururangi, nga hau popoki o runga."—A, piki ware noa a Karihi; i a Tawhaki nga karakia.

Ka piki raua, ka moa. Ka patua iho a Karihi e nga hau a te Ururangi. A, kei te piki ano a Tawhaki; whawhai rawa kia Karihi, kua makere ki raro i te kainga a Whaitiri. Ka tukua ki raro a Tawhaki; tau rawa iho ki te Tuakana kua mate i a Whaitiri.—A, ka piki ano tera, a Tawhaki, ka patua iho e te hau o Ururangi: piri rawa ki te moana. Piki ano a Tawhaki. Ka eke ki runga. Pono rawa a Tawhaki, e heke ana mai, a Tuna. Ka tutaki raua, ka ui atu a Tawhaki ki a Tuna: "Tena koe te haere mai. He aha koe i haere mai?"—"He tahuna no runga, he maroke no runga, he pakeke, kakore he wai." A, ka heke mai a Tuna; ko te Kawa, ko Maraenui e mau mai ana ki te rae o Tuna, e koparetia ana. Ka matamatarongo raua, ka tukua mai a Tuna. No reira e takoto noa a Tuna i te horehoretua; kahore he wai. Ka whakamanawa a Tuna ki raro ki te Muruwaioata, ki te wai takoto ai.

Ka haere a Tawhaki, ka whakarongo e korero haere mai te whanau a Tangaroa. Na, ka tukua atu. Ka haere a Tawhaki, ka tutaki ki a Hapainuiamaunga, ka tutaki ki a Hinenuiotekawa, ka haere ki te kainga noho ai. A, whano atu ano a Tawhaki, ka tangi mai nga iwi o te hakoro, ka oho mai ki a Tawhaki. Ka karakia a Tawhaki.—Ka noho a Tawhaki i te kainga o Paikea ma, ka mate te wahine, ko Hinenuiotekawa, ki a Tawhaki, ki te tangata ataahua. Ka ahiahi te ra, ka noho nga tangata ki te taha o te ahi. Ka whakatete te tangata nana te wahine. Ka whakatete a Tawhaki ki a ia. —Ka tare te wahine ki a Tawhaki, ka whakarere i tona tane, ka noho i a Tawhaki. A, ka hapu taua wahine i a Tawhaki. Na, ka ki atu a Tawhaki ki nga tangata kia haere ratou ki te wahie. Koia te kaiwhakatari a

Tawhaki! Ka haere a Tawhaki haere i te kaiwahie. Ka whakawaha te kaiwahie; ka amohia e Tawhaki. Ka tae mai te kaiwahie, ka tukua; ka whakamutu te tuku o nga wahia, ka tukua e Tawhaki tana wahie, kotahi te wahie a Tawhaki, he wahie roroa. Ka whakana nga korohi a Paikea ma. Ka puta ki waho, ka korero ratou. Ka mahara a Tawhaki; tenei te take i oho ai oku tuakana.—Ka noho ano a Tawhaki, ka ki atu ki te wahine: "E puta tou tamaiti, e puta he tane, me waiho te ingoa o tau tamaiti, ko toku wahie, ko Wahieroa."

Ka noho a Tawhaki, ka ao te ra, ka haere, ka whai i te rangi i a Tamaiwaho i runga. A, ka whana atu a Tawhaki, e haere ana a Tamaiwaho; e ripekatia honoa te rangi e Tamaiwaho. Whaia ake hoki a Tawhaki i te rangi;—ripekatia honoa hoki. Ka whaia ake tonu a Tawhaki;—e ripekatia honoa hoki te rangi. Ka karanga iho a Tamaiwaho: "He aha tahau e whai mai i au?" Ka karanga ake a Tawhaki: "Tukua mai ki au tetahi." Ka karanga iho a Tamaiwaho: "Kahore, kahore." Ka karanga ake a Tawhaki: "Tukua mai ki au tetahi, hei utu mo toku matua." Ka karanga iho a Tamaiwaho: "I whai mai koe ki au, te tangata kino!" Ka karanga ake a Tawhaki: "He tangata ataahua au, he tangata kino koe." Ka kohara ki a ia a Tamaiwaho, ka pono a Tawhaki. Ka karangatia e Tawhaki: "He tangata kino koe." Ka kohara a Tawhaki, ka pono te ringa a Tamaiwaho. Ka karanga iho a Tamaiwaho: "He tangata ataahua koe." Ka karanga ake a Tawhaki: "Tukua mai tetahi ki au." Ka tukua iho e Tamaiwaho, ka karanga iho: "Ka mutu, ka mutu." Ka karanga ake hoki a Tawhaki: "Tukua mai." A, ka tukua mai e Tamaiwaho: "Ko te Whatu, ko te Ateateanuku, ko te Ateatearangi, ko Hurihangatepo, ko Hurihangateao, ko te Mata, ko te Koruehinuku, ko te Mataateawhaki, nana i ouhou te aitanga a Pukukitemoana. Ka puta Ihupuku, ka puta Papaikore.

4. *Ko Wahieroa.*

Ka noho a Motokarautawhiri i a Wahieroa; ka hapu te wahine. Ka haere a Wahieroa ki te mea manu ma te hapu. Ka mauria mai te manu, he koko. Auina ake ka haere hoki a Wahieroa ki te mea manu ma te hapu, ka rokohina atu te wahi koko a Matuku. Ka hopukina a Wahieroa e Matuku, ka patua, ka mate a Wahieroa, ko te paihi i whakarauorangia.—Ka noho te wahine, a Motokarautawhiri, ka puta ki waho te tama, ko Rata tona ingoa.

5. *Ko Rata.*

Ka whakatupukia a Rata e te hakui. Ka ui mai a Rata: "Keiwhea ra taku nei matua?" Ka ki atu te hakui: "Kua mate."—"Na wai?" "Na Matuku. I haere tou hakoro i te mea kai mahaku. Ka hapu koe, ka hia kai

au, ka haere ia ki te wahi a Matuku. Ka mate ia." Ka ki atu a Rata: "Keiwhea tona kainga?"—"Me titiro koe ki te putanga mai o te ra; kei waho ke kei te moana, ekore e tae."—Na ka noho te hakui. Ka haere ki te wahie, ka porangi; ka kite i te rakau, he rakau pai, he totara. Ka mauria mai te pua o te rakau. Ka ahiahi te ra, ka korero atu tera ki te tama:—

"Kua kite au i te rakau, he rakau pai, he totara. Apopo ka haere ai ki te toro i toku rakau." Ka ho atu ki te pua, kia kite a Rata.—Ka haere a Rata ki te porangi. Ka hoki mai, ka ki mai: "Kahore kia kitea e au." Ka ki atu te hakui: "Ekore e ngaro i a koe. Kei te rakau taratara te ra, koia tena." Ka haere a Rata, ka porangi. Kahore hoki kia kitea. Ka ki ano te hakui: "Ekore e ngaro i a koe. Kei te rakau taratara ano." Ka haere, ka hoki mai a Rata, kua kitea taua rakau. Ka ki atu te tama: "Me aha?" Ka ki mai te hakui: "Ki nga toki a au tupuna." Ka ki atu te tama: "He puruhia enei toki, kahore he niho." Ka ki atu te hakui: "Nau mai, haere. Kawe, e whakairia ana ki runga ki te tua iwi o tou tupnna, ko Hinetuaoaka."—Na, ka ki te waha o te hoanga: "Kia koi, kia koi, kia koi."—Na, kua koi. Ka houia.

A, ka ahiahi te ra, ka moe. Ka ao ake i te ata ka haere a Rata. Ka tuaina taua rakau; ka hinga ki raro, ka topea te kauru o runga. Ka haere mai tera, a Rata, ka tae mai ki ro o te whare, ka noho. Ka ao ake i te ata, ka haere ki taua rakau. Rokohina rawatia atu, kua arahia ki runga.—Ka tuaina, ka hinga ki raro, ka topea te kauru, ka haere mai tera ki te kainga. Ka ki atu tera ki te hakui: "Whana atu rawa ahau, kua tu ki runga te rakau." Ka ki atu te hakui: "I ahatia e koe?"—"I tuaina makuwaretia e au?" Ka ki atu te hakui: "Me tua wareware ou tupuna!"—"Ae, i tuaina tonutia e au." Ka ki atu te hakui: "Nau mai, haere hoki." Ka tae atu a Rata ki taua rakau ano. Kua tu hoki. Ka tuaina; ka hinga ki raro, ka kotia te kauru; kua ahiahi. Ka peke mai tera, a Rata, ki tahaki, tu atu ai. Ka whakarongo tera e haruru ana mai, e whakahua ana i tona ingoa. Ka whakarongo tera e karanga ana mai:

"Ko Rata, ko Rata a Wahieroa,
Tuatuaina makuwaretia e koe,
Te wao Tapu o Tane.
Kihu maota o Tane.
Ka rere te maramara ki te puhaka,
Ka rere te maramara ki te kauru.
Koia e piri, koia e tata.
Koia tautorotia.
E tu pa whaia!"

Kua tu ki runga te rakau.

Ka whana atu, ka hopukia e Rata; ka mahue, ka memeke nga tangata ki tahaki. Ka ki atu a Rata: "Koia nei ano e mea i taku rakau nei. Koia nei ano e rawehanga i toku raku nei."—Ka ki mai: "Haere koe. Waiho tou rakau ki koneitakoto ai; ma matou e whaihanga atu." Ka tae tera ki te kainga, ka korero atu ki te hakui te mea o taua rakau, te hopukanga.

Na, ka moe tera. Ka ara ake i te ata, kua tae mai ki te tara o te whare, te waka. Ka puta atu a Rata ki waho, tenei e takoto nei, i te tara o te whare, kua oti i aua tupuna nei, te waka nei.—Ka ao ake i te ata, he rangi ko, ka kawea ki te moana, taitai ai. Ka mauria mai nga ika i runga. Ka tae mai, ka kawea nga rimu ki mua, kia karakia. Ko aua rimu ra i kawea ki mua, taitai ai. Ka tunua te ika, ka kainga. Ka takoto tetahi. Ka auina ake te ata ka taona tetahi ika, te rua o aua ika ra. Ka kainga te ika; ko te tapora whakairia hei raupaka. Na, auina ake ka toia te waka; ko Niwaru te ingoa o taua waka.—Ka haere te taua; ka tae ki te kainga o Kioreroa raua ko Kiorepoto. Ka karakia tetahi:

"Kiore, kiore, mataki te whakarua.
Waiho, kiore, kia tau ana tona whare;
Te whare o Tunui, te whare o Tangaroa.
Whiti maumaua, ko Taraiawatea.
Huie, Taie, Rona, Hana, Haere mai, Toki, Hauma."

Ko Kiorepoto i puta, ko Kioreroa i mate. Ka mauria mai a Kioreroa, te tangata i mate. Ka tae mai ki te kainga i te hakui. Kahore ano kia ea te mate.

Ka huaina a Rata, ka haere, ka hoe ki te moana. A,—ka tae ki te kainga i te paihi. Ko Tamauriuri te ingoa o te paihi; e noho ana i Puoronuku, i Puororangi. Ka ui atu a Rata: "Keiwhea tou rangatira?" Ka ki mai: "Kei ko ano. Ko au ano tenei e waiho nei hei tiaki i nga mara." Ka ki atu a Rata: "Ekore ranei e tae mai?" Ka ki mai taua paihi: "Ekore e tae mai. Ki iho ki au, hei tawhitu, hei tawharu ka haere mai ia kia tamahungia a maua koti puwha." Ka ki atu a Rata: "Ekore koe e Karanga?" Ka karanga a Tamauriuri: "Matuku e! Nau mai ra kia tamahungia a taua kotinga puwha." Ka karanga mai a Matuku: "Kei te whakehe koe i nga po o Matuku. Hei tawhitu, he tawhara ka haere atu ahau ki te tamahu ki a taua koti puwha." Ka karanga ano a Tamauriuri: "Matuku e! Nau mai ra; whaia a taua koti puwha." Ka karanga a Matuku: "Kei te whakaporo koe i te manawa o Matuku. Akuanei rawa ano koia a Matuku."—Kua takoto te mahanga a Rata ki Runga ki te rua o Matuku. Ko Putawarenuku te ingoa o te ana. Ka karakia a Rata:

"Taku mahanga nei ka here ki runga,
Ka here ki te tangata takitaki taua.
Ko Herenuku ai e, ko Hererangi ai e.
Ka whiwhia, ka rawea, ka moua."

Na, ka puta ake a Matuku. I raro ano a Matuku, ko te huruhuru kua puta ake. Ka puta ki runga ka noho te mahanga ki te kaki. Ka mate a Matuku. Na, ka ea te mate; katahi ano ka rite.

6. *Ko Tuwhakararo.*

Na Rata a Tuwhakararo. Ka noho a Tuwhakararo i tana wahine, i a Apakura, ka puta ki waho tana tama, ko Whakatau. A, ka haere a Tuwhakararo ki te tira; ka noho ki te wahine, ko Hakirimaurea te ingoa o tenei wahine. Ka patua a Tuwhakararo e te aitanga a Raeroa, ka mate.

7. *Ko Whakatau.*

Ka rongona e Whakatau te mate o tona hakoro; ka whakarongo ia ki tona hakui e tangi ana: ka whaihangatia te waka. Ka pania te waka, he taha pako tetahi taha, he taha ma tetahi taha. Ka manu ia te waka, ka haere a Whakatau i te moana. Ka tata ia ki waho ake o taua kainga, ka kitea mai e nga tangata. Ka karanga nga tangata: "He pakaka!" Ka rere etahi tangata ki ro o te wai, kaua ana. Ka tae atu he tangata ki te waka, ka karanga atu ia ki a Reinuiatokia, i reira e manu ana: "E hoki koe." Ka karanga a Reinuiatokia: "Whakataha." Ka whakataha ia ki te ihu. I reira ia a Whakatau. Ka hiko ia ki te toki; ka ea te tangata, ka whakakitea atu tona kanohi, ka 'pakaina ki te toki, ka mate. Tokomaha o nga tangata i mate i a Whakatau. Ka tae atu a Mongotipi, ka pakaina e Whakatau ki te toki; ka tipa ia, ka kau, ka haere ki uta. Ka korero atu ia ki nga tangata: "He waka. Ko Renuiatokia tetahi tangata, ko tetahi ia kahore au i kite, he tangata ke ia."

Ka hoki mai ia te waka, ka tae ki tawhiti, ki waenganui o te moana. Ka po, ka ki atu a Whakatau ki nga tangata, kia hoea ki uta. Ka whakaukia ia; ka ki atu ia ki nga tangata. "Haere koutou. Ki atu ki a Apakura, he po, ka kitea te wera o Tihiomainono.—Ka noho a Whakatau i ro o ngaherehere; ka whakaaro ia i roto i tona ngakau. Ka mutu; ka whakatau i tona kanohi ki te pungarehu. Ka haere ia, ka tutaki i te kaiwahie, e haere mai ana: ka hopukina. Ka whatiwhati wahie nga tangata. Ka ki atu a Whakatau: "Whatiwhatia hoki etahi wahie mahaku." Ka nui ia a ratou kawenga, ka haere ki te kainga. Ka tata ia, ka karanga atu nga tangata: "Ina ia ta matou nei tia!" Ka karanga mai nga tangata: "Arahina mai ki konei." Ka haere ia ki reira, ki roto ki te whare noho ai. Rokohina atu ia i tautahua i nga tupapaku i roto i te whare.—Ko Tihiomainono te ingoa o tenei whare.—Ka kitea mai nga iwi o te hakoro i a ia, ka tangi mai ki tana tamaiti. Ka ki ake nga tangata: "Mawai ia tou mate e utu mai?"—Ka po te ra; ka korero nga nga tangata, ka ui atu ki a Mongotipi: "Pewhea te ahua o taua tangata i runga i te

waka?" Ka ki mai a Mongotipi: "Kahore ia i kitea te ahua whenei me taua tangata." Ka ui atu tetahi: "Me au nei te ahua?" Ka ki mai a Mongotipi: "Kahore ia he tangata i konei e rite ana te ahua." Ka karanga atu a Whakatau: "Me au nei te ahua?" Ka titiro mai a Makotipi, ka karanga atu ia: "Koia ano tenei ake te ahua; tenei te tangata"—kua tika te ahua a Whakatau. Ka rere mai nga tangata ki te hopu i a ia. Ka hikoia ki te taha, ka ringihia, ka mate te ahio runga o te tuaroko. Ka whai ia i nga iwi o te hakoro, ka puta ki waho, ka paea te whare, ka tahuna te whare, ka weraia nga tangata i roto; ka haere ia. Ko te ingoa o tenei ahi, ko Ruruarama.

Kei te noho a Apakura i runga i tona whare, ka titiro atu. Ka kitea e ia te huru o te ahi. Ka mau ia te huruhuru ki te rangi. Ka pepeha te hakui: "Ko Whakatau, potiki ahaku, e Whakatane i a ia!"—A, ka hoki mai a Whakatau ki te kainga. Kua ea te mate o te ha' oro.

8. *Ko Tinirau raua Ko Hineteiwaiwa.*

Ka tae te rongo o Tinirau ki a Hineteiwaiwa: kotahi te tangata e noho ana, ko Tinirau, he tangata ataahua. Ka mea a Hineteiwaiwa kia haere ki a Tinirau, mahana. Ka haere; ka rokohina atu e pae ana te mako. Ka ki atu a Hine: "Te ika nei, te ika nei! Ehara koe i te ika kokirikiri o Tinirau." Ka haere, ka kite ia i te pakaka, ka ki atu: "Te ika nei, te ika nei! Ehara koe i te ika kokirikiri o Tinirau."—Ka haere taua wahine, ka tae atu ki te kainga o Tinirau. Rokohina atu nga wai whakaata o Tinirau. Ka tukitukia; etoru nga puna, pae anake. Tukituki, pae rawa nga takitaki me te maihi o te whare. Ka kitea mai e Ruruwareware, e Rurumahara. Ka tae atu ratou ki te whare o Tinirau; ka ki atu a Rurumahara: "Kua pae nga puna wai whakaata o Tinirau." Ka ki atu a Ruruwareware; "He parau ia." Ka ki atu a Rurumahara: "Na wai i ki, kua pae." Ka ki atu a Ruruwareware: "He parau ia, kahore kia pae." Ka ki atu a Tinirau: "Noho marie korua; mahaku e tora atu.

Ka haere a Tinirau. I tawhiti ano, titiro mai, kua pae. Ka tata mai ki taua wahi wai, ka kohara a Hineteiwaiwa ki a Tinirau. Ka kohara a Tinirau ki a Hineteiwaiwa. Ka hopukina a Tinirau e Hineteiwaiwa. Ka noho raua. —A,—ka korero, ka ki atu a Hine, ki a Tinirau: "E aha koia koe e haere ki te moana, he ika koia tahau?" Ka ki mai te tane: "Kahore tahi aku ika." Ka ki atu te wahine: "Tena, e haere koe ki te moana, e hutia, e mau ano tau maka me tau mahe?" Ka ki mai te tane: "Na wai i ki." Ka hutia ake taku aho kua kore aku maka, kua kore taku mahe.

Na, erua nga wahine a Tinirau i te kainga e noho ana, ko Makaiatuauriuri te ingoa o tetahi, ko Makaatuahaehae te ingoa o tetahi. Ka tonoa e aua wahine a Ruruwareware raua ko Rurumahara. Rokohina mai e noho ana a

Tinirau rau ko Hineteiwaiwa. Ka titiro, ka hoki atu. Ka ui mai nga wahine: "Keiwhea?" Kiia atu e Ruramahara: "Na ia, kei te kainga wai whakaata."—"Kei te aha?"—"Kei te noho raua ko tona hoa." Ka ki atu a Ruruwareware: "Ko Tinirau anake i kitea." Ka ki atu a Rurumahara: "Erua nga tangata i kitea e au." Ka ki atu a Ruruwareware: "He parau ia." Ka ki atu a Rurumahara: "I kitea ano e au, e rua o nga upoko, e wha o nga waewae." Ka mea nga wahine a Tinirau, ma raua ano e haere.

I noho ano a Tinirau raua ko Hineteiwaiwa i te kainga o nga wai whakaata. Ka hemo raua i te kai, ka ki atu te tane: "Haere taua ki te kainga, ka mate taua i te kai." Ka mea te wahine, kia noho; ka karakia: "Tukutuku iho ana, hekeheke iho ana"—kua pu nga kai ma raua. Ka kai raua i aua kai. Ka hemo raua i te hauaitu, ka ki atu te tane: "Haere taua ki te kainga, ka mate taua i te mataotao." Ka mea atu te wahine: "Tukutuku iho ana, hekeheke iho ana."—Kua pu nga weruweru kua mahana raua.

Ka puta mai nga wahine a Tinirau, ka ki atu te waha o Tinirau ki a Hineteiwaiwa: "Kia ata tu i ou taokete." Ka ki mai tera: "Ahakoa he riri, he hanga kino e haere mai na aua wahine—." Na, kua tata mai. Tu tonu atu a Hine ki runga, ko te mata ko te rakau i a ia. Homai tou te rakau a tetahi wahine ki a Hine, ka ngaro atu, ka taho. Ka pakaina e Hine ki te rakau, ka mate ra tetahi. Tu tonu mai tetahi; ho mai te rakau. Ka ngaro atu a Hine, ka taha. Ho atu te mata, kua mate tera wahine, tokorua, mate anake. Ka haea nga puku ka karanga a Hine kia Tinirau: Titiro mai i au tamariki." "Pu ana mai nga mahi i waho, me nga taipu kainga.

Ka noho a Tinirau raua ko Hineteiwaiwa; ka hapu te wahine i a Tinirau. Ka puta mai he tamaiti. A, po maha noa atu noho raua. Ka whiti te rau, ka haere raua ki waho, ki te wahi taumarumaru noho ai. Ka ki atu te wahine: "Hakurekia toku upoko." Ka hakurekia te upoko o Hine e Tinirau. Ka mutu, ka ki atu te waha a Tinirau: "Hakurekia toku hoki." A, hakurekia ake e Hineteiwaiwa te upoko o Tinirau.—Ka puta mai te Porewakohu, me te ruru rahi te ahua; i roto a Rupe, he tungane no Hineteiwaiwa. Ka tata mai, ka kitea he tangata: ka tangi mai.

"Ko Rupe—ko Rupe--te tungane;
Ko Hine—ko Hine—te tuahine."

Ka tangi atu a Hineteiwaiwa.

"Ko au tenei—ko Hine—te-iwaiwa.
Ko Hinetangarumoana."

Whaia iho e Rupe, ka mauria atu te tuahine me te tamaiti hoki. Ka karanga atu a Tinirau; "E Rupe, whakahokia mai a taua tuahine." Kahore hoki. Ka riro tonu i a Rupe.—I reira hoki i rongona, ko tetahi ingoa o Hineteiwaiwa, ko Hinetangarumoana.

Na, ka noho tera, a Tinirau; ka mea he ara mahana, kia haere ia ki te wahine. Ko te tupuna, ko Tutunui—he ika no te moana. Piki tonu tera ki runga ki te tupuna haere ai. Ko nga mokaikai tukua ra uta hei whakarongo i nga kainga. Ka tae nga manu ki tena kainga ka tangi, ka rere. A, kei te haere ano a Tinirau i runga i te tupuna, i waho o te moana haere ai.—Ka tutaki ki a ia a Kae, e haere ana i runga i te mokihi. Ka tata mai, ka ki atu te waha a Kae ki a Tinirau: "Ho mai kia whamatau ahau ki runga ki tahau." Ka ki atu a Tinirau: "Ho mai hoki tahau ki a au." Ka whiti atu a Kae ki runga ki ta Tinirau: ka whiti atu hoki a Tinirau ki runga ki ta Kae. Ka haere a Kae, ka riro hoki a Tinirau. Ka karanga atu a Tinirau: "Kauraka e tuku kia papaku te wai; hei te hohonutanga ano hei tuku to taua tupuna."

Ka rere a Kae. A—, na te wai tanu ka papaku, ru rawa ake a Tutunui i a Kae, kia taka ai ki raro. Kahore hoki kia taka. Ka tae ki te pati; oi noa a Tutunui. Kua mau ia, kua ki te piha i te paruparu. Ka mate a Tutunui, ka kotia katoatia, kainga e Kae.

Ka manu a Tinirau. Kahore hoki kia kaneke te hoe i runga i te mokihi. Ka karanga atu tera ki a Otitipa, ki te wharereperepe. Ka tomo a Tinirau ki roto tere ai. Ka whakarongo ia ki te tangi a nga manu. Ka tae ki te kainga ka tangi nga manu, a ka rere. A—, ka tae ki tetahi kainga e tumo ai te tangi o nga manu, ka mahara tera, ko te kainga ano tenei.

Ka u tera ki uta; ka haere, ka tutaki ki te teina a Hineteiwaiwa. Ka ui atu a Tinirau: "E haere ana koe ki whea?" Ka ki mai taua wahine nei: "E haere ana ahau ki te wahi e patua ma nga weru o toku iramutu, o te tamaiti o Hineteiwaiwa raua ko Tinirau." Ka ki atu tera: "Ho mai, mahaku hoki e patu etahi." Ka ki atu te waha o taua teina: "Na wai i ki, mahaku ano e patu." Ka uaua atu ano a Tinirau, a ka patu etahi. A ka ma, ka ngawari, ka ho atu kia mauria atu.—A, ka tae atu te teina ki te kainga ka korerotia ki te tuakana te tangata i tutaki ki a ia, i patu ra i etahi o te weruweru o te tamaiti. Ka ki atu te waha o te tuakana: "Ho mai ki au etahi karetu nei." Ka tuponakia e rua. Ka ki atu ki te teina: "Haere koe, pakaina atu te mea tamatane; e mau, ka hoki mai koe." Ka haere te teina, ka pakaina atu te mea tamatane: Ka hopukina e Tinirau, ka mau. Ka haere te teina ki te kainga, ka ki atu ki te tuakana: "Pakaina atu e au hopukina mai, mau to." Ka noho raua ko te tuakana.

Ka ahiahi te ra ka ki atu te tuakana: "Akuanei koe ka haere ki te whare tako. E panaina koe ki waho kia uaua tou koe te haere ki roto." Ka haere te teina, ka tae atu ki te whare, ka aruarua atu mai ki waho. Ka uaua tou tena ki ro o te whare; ka ki atu; "Na Hineteiwaiwa ahau i tono mai." Ka ki atu nga tangata: "Aua ra kei te whakahou kau koe ki te tamaiti a Hine, he

tamaiti tapu." Ka ki atu te teina: "Na Hine ano i ki mai, kia haere mai au ki ro o te whare. No te tamaiti hoki ia e ai ona matua hei whakatapu; tena he tamaiti kahore tona matua hei whakatapu—." A, ka haere ia ki ro o te whare, ka noho.—I te po ano ka whakarongona mai te tatau o te whare o Hine raua ko te tamaiti e uakina ana—he tatau pounamu. Ka karangatia atu e nga tangata: "E Hineteiwaiwa! Ko wai e uakina te whare o te tamaiti?" Ka karangatia e Hineteiwaiwa: "Ko au tenei e haere ana au ki te mianga." He parau ia, ko Tinirau ia te uaki i te whare. Ka moe raua ko te wahine. Ka ao te ra, ka puta te wahine ki waho, ka karanga: "Tenei ta koutou taokete." Na, ka heke mai nga tangata kia kite i a Tinirau. Ka haere mai nga hakoro, nga tuahine ka tangi ki a ia. A, ka noho a Tinirau i te kainga o te wahine.

A, ka noho a Tinirau ka whakaaro ki a Tutunui. Ka moe, ka ao ake i te ata. Ka haere ki runga ki te taumata whakamono ai ki a Tutunui, a—ahiahi noa te ra. Ka ao ake i te ata ka haere ki runga ki te taumata whakamono ai. Mahiiti noa nga hau, ka whiti te rawaho; na, kua tae mai te kakara ki te ihu o Tinirau. Ka pepeha tera: "Ai te kakara o Tutunui e ho mai e te hau nei!" A, ka haere mai a Tinirau ki ro o te whare tangi ai. Ka rongona e nga tuahine, ka haere mai ratou ka tangi.—Ka mutu ka ki atu tera ki nga tuahine: "Akuanei haere koutou ki nga pa, ki nga kainga whakarogo ai. Ekore hoki e ngaro i a koutou. Te tangata e mau na nga tupuni ka oti te tuitui nga weruweru. Na, e kata, e pahore nei nga niho, te tangata niho weha ko Kae."

A, ka haere nga tuahine; ka manu ko nga mokaikai i runga haere ai. A, ka tae ratou ki tetahi kainga, ka haka ratou. Ka mutu te haka ka haere, ka manu ratou. A—ka tae ratou ki te kainga o Kae. Ka tumo te tangi o nga manu. Ka mahara ratou: "Ko te kainga tena; ina hoki kei te tumo te tangi." Ka u ratou, ka tae ki ro o te whare. Rokohina atu a Kae e noho ana i te poupou tokomanawa. Ka haka ratou. Kahore hoki a Kae kia kata; piko tou a Kae. A, ka ahiahi te ra, ka ka nga ahi, ka marama te whare, ka haka ratou. Ka kata nga tangata, kahore hoki a Kae kia kata. Kohititia ai ratou, ka kata a Kae, te tangata niho weha. Ka mutu ratou, ka rehua a Kae ki te moe.—Ka haere ratou ki waho, ka taia te purerangi, ka taia te rohe.

> "Taia te rohe me rohe. Ko te rohe na wai?
> Ko te rohe a Maitihitihi, a Mairekareka.
> Taia te kohau me kohau. Ko te kohau na wai?
> Ko te kohau a Maitihitihi, a Mairekareka.
> Taia te kohau me kohau."

Ka hoki mai ratou ki ro o te whare. Rokohina mai a Kae e moe ana. Ka whai atu, ka hikitia ki roto ki te purerangi; oriori mai ki roto ki te tata. Ka kawea atu a Kae.—A, hei te ata ka tae atu ki te kainga o Tinirau. Ka u. Ka rongona e nga tangata e kata ana nga tuahine. Ka kawea a Kae ki te kainga ka tukua. Ka haere mai a Tinirau. Ka ao te ra ka whakaara i a Kae.

Ka ki atu a Tinirau ki a Kae: "Titiro, nahau ano tenei kainga?" Ka ara a Kae ki runga, ka titiro.—Ka whaia atu te ringa a Kae e Tinirau. Ka aue a Kae. Ka ki atu a Tinirau: "I aue hoki a Tutunui i tona kiri." Ka patua a Kae hei utu mo Tutunui. Ka ea te mate o tona tupuna.

Ka noho a Tinirau, a—maha noa nga ra i noho ai, kahore hoki i tae ki te mahi kai. Ka haere mai te wahine, a Hineteiwaiwa, ki te hunga wahine noho ai. Ko pono atu e nga wahine: "Kahore ia tou tane e haere ki te mahi kai." A, ka tangi te wahine, ka haere ki tahaki. Ka kitea e te tane, e Tinirau, ka ki atu tera: "He aha koe e tangi na?" Ka ki atu te wahine: "He pononga mai au, he kinga: kahore tou tane e haere ki te mahi kai mahau." Ka ki atu te tane: "Kahore, e hua ana, he ki marie mai."—Ka ahiahi te ra ka ki atu a Tinirau ki te wahine ki a Hineteiwaiwa: "Apopo ka haere ai koe ki au tangata, ki atu ai, kia topea etahi poupou, hei whaihanga i nga whata, i nga whare kai."—A, ka haere nga tangata ki te tope rakau, ki te pikau mai, ki te hanga whare kai. Ka ahiahi ka noho, ka moe. Auina ake hoki haere ratou ki te mahi rakau. A, ka ki mai te hunga e mahi ana: "Kati. He aha te kai hei uta? "Ki tonu a Tinirau ki te wahine, kia tonoa nga tangata ki te mahi whaihanga whata. A, ka nui te amuamu a nga tangata, ka ki atu, "Kati." Ka ki atu a Tinirau ki a Hineteiwaiwa: "Haere, ki atu ki nga tangata, kia wahia mai tetahi kauwati." A, ka wahiatia mai, ka hoatu ki a Tinirau. Ka ahiahi te ra, ka haere ki tatahi ki te pure ki te oneone. Ka oti te pure, ka hoki mai tera ki te kainga. Ka tomo mai tera ki ro o te whare, ka tau mai te ika o te kawa ki te roro o te whare o te tamaiti, takoto ai. Kei ro o to ratou whare nga tangata e moe ana. Na kei te whakareia noatia nga ika e te moana. Kakirikiri noa nga ika ki runga ki nga whata, ki runga ki nga kaupapa; whaoa noatia nga iki ki roto ki nga whare kai. Ka hinga nga whata, ka hinga nga kaupapa, ka pakaru nga whare kai, pakaru nga takitaki. Rere tou mai nga ika ki te marae.—I rongo noa nga tangata ki te harurutanga o nga iki, i ronga i te pukarutanga o nga kaupapa: mataku nga tangata.

Ka awatea, ka oho nga tangata, whanaatu ki nga marae; kahore hoki he huanui; he ika anake e pu ana. Kotahi ano te whare i atea, no te tamaiti anake. Kotahi tou te ika i reira, ko te ika anake i te kawa.

ART. II.—*Researches and Excavations carried on in and near the Moa-bone Point Cave, Sumner Road, in the Year* 1872. By JULIUS HAAST, Ph.D., F.R.S., President.

Plates I. and II.

[*Read before the Philosophical Institute of Canterbury, 15th September*, 1874.]

IN the spring of the year 1872, Mr. Edward Jollie suggested to me that the Moa-bone Point Cave, near Sumner, if properly examined, would doubtless yield important and interesting results. My friend thought that by making there extensive and careful excavations, the question as to the period of the extinction of the Moa would be, if not entirely solved, at least considerably advanced, and that even the ground near the entrance of the cave, many acres in extent, if properly investigated, would offer additional evidence for the elucidation of the subject. On my remark that no funds for such an undertaking were at my disposal, Mr. Jollie headed at once a subscription list for the purpose, followed by a number of gentlemen who took an interest in the matter, and which, assisted by a grant from the Philosophical Institute of Canterbury, soon placed the greater portion of the necessary funds in my hands.

After having obtained the permission from Mr. Alfred Claypon Watson, Sumner Road, on whose property the Sumner cave is situated, I began the work of excavation on Monday, 23rd September, and ended on Saturday, 9th November, 1872, the same having thus been accomplished in seven weeks, during which time I occupied always two labourers working under my directions.

I may be allowed to present here my warmest thanks on behalf of the Canterbury Museum to the subscribers of the funds, of which the details of expenditure will be found in Appendix A, and to Mr. Watson, the owner of the soil, for his permission to undertake the work.

I wish also to apologise to them that I have not been able before to-day to lay the results of these excavations and researches before them. However, I must plead, in extenuation, that the bulk of this paper was written more than a year ago, but that I was then compelled, from want of room in the Museum, to repack the extensive collections made during these excavations, before I found the time to examine them thoroughly, and describe them in detail; and only in the last few months I have managed to make the necessary space in one of the work rooms for doing so.

Before entering into a description of the results achieved, I think it will be expedient to offer a few general observations on the geological features of the

cave and of the surrounding country, as in the summing up it will be necessary for me to refer to them in elucidation of some of the points at issue.

Geological Features.

Banks Peninsular, an extinct volcanic system of large dimensions, standing as an island, in post-pliocene times, in the sea, shows by the configuration of its base that an oscillation averaging about 20 feet in vertical height has taken place, the country being depressed and afterwards raised to about the same altitude again. This line is well visible travelling round Banks Peninsula to its western termination, where, when we reach that altitude above the sea level, the signs of a former submersion disappear below the newer fluviatile and lacustrine deposits.

During and after the small submergence of its base, this portion of Banks Peninsula was of course subjected to the fury of the waves, when in favourable localities caves were formed, either by the removal of loose material (tufas) between two harder lava streams, or by the enlargement of pre-existing hollows, such as are found as air bubbles, often of gigantic size, in lava streams running generally parallel to the direction of their flow.

In this instance there is no doubt that the Moa-bone Point Cave is a pre-existing hollow in a doleritic lava stream, which has been enlarged by the enormous power of the dashing waves of the ocean beating here at one time furiously against the northern foot of the Peninsula.

In previous publications (amongst others, "Report on the Formation of the Canterbury Plains, 1864," page 22, *et seq.*) I have shewn how in post-pliocene times from the material brought down by the enormous glacier torrents, forming huge shingle fans at the foot of the glaciers, two bars were thrown across the sea; one to unite the northern, or Waimakariri-Ashley deposits, with the northern slopes; another to connect the southern or Rakaia-Ashburton beds of the same nature with the southern slopes of Banks Peninsula, behind which a huge lake was formed, of which Lake Ellesmere is the last remnant. Of the northern bar we can trace the inner or western shores through Kaiapoi to the neighbourhood of Woodend.

In this large fresh-water lagoon (occasionally an estuary basin) the Waimakariri, Selwyn, and sometimes the Rakaia discharged their waters, having an outlet near the north-western slopes of Banks Peninsula, of which, in going towards Cashmere, the residence of Sir Cracroft Wilson, we can easily trace the lines of dunes and shingle by which the eastern shore of that lake was formed, being in the beginning very narrow, and only gradually, as more and more material was added, assuming a greater breadth. Thus we are able to follow the different lines of these earliest-formed beds from the neighbourhood

of Kaiapoi, where they are comparatively narrow, along the eastern boundary of Christchurch to the northern foot of the Peninsula, gradually diverging more and more.

In my former paper, entitled "Moas and Moa Hunters" ("Transactions of the New Zealand Institute," vol. iv., page 89), I have already alluded to the fact that the ovens of the moa hunters were confined to the inner lines of these dunes, and a further close examination of the district between Christchurch and New Brighton has confirmed fully my former more local observations. Thus it is evident that when the former inhabitants of this part of New Zealand existed principally upon the chase of the Moa, the sand dunes had scarcely reached the foot of the Peninsula, where now the Ferry Road crosses the Heathcote, and consequently that the whole breadth of the sand dunes from opposite that locality to the Sumner bar, where they have now their south-eastern termination, have been formed since.

There are some Maori ovens and kitchen middens on the northern side of the Heathcote estuary, but they invariably contain only shell-beds.

Position of the Cave.

When the cavity now called the Moa-bone Point Cave was enlarged by the waves of the sea, the estuary of the Heathcote-Avon in its present form was not yet in existence. Close to this cavity, on its western side, a hard doleritic lava stream, now passed through by the Sumner Road cutting, reached for some distance into the sea, forming a small headland, against which, principally on its eastern side, the waves of the Pacific ocean broke with considerable force. Masses of rock were detached by the surf being taken along in an easterly direction for about a quarter of a mile forming a ridge, gradually becoming lower and losing itself amongst the sands.

The formation of this ridge principally took place when this portion of the peninsula was some 12 to 15 feet lower than at present, the upper line of boulders being about 16 feet above the present high-water mark. When the land rose again the sea was cut off by this boulder ridge from the entrance of the cave, a huge rock lying here nearly across, protecting it at the same time from being filled up by the deposits of drift sands now forming on the flat close to it.

A second and lower line of boulders was formed in front of the former, about 5 feet above the present high-water mark, with a small terraced space behind it. Since then other deposits, formed in the Avon-Heathcote estuary, have been added as a small belt in front of this last line of boulders, brought into its present position by the action of the open sea.

In section No. 1 (Plate I.), I have given the necessary details in illustration of these points.

SECTION NEAR SUMNER
FROM ESTUARY OF RIVER HEATHCOTE TO A CAVE.
TRANS. N.Z. INSTITUTE, VOL. VII. PL. I.
SECTION No. 1.
ESTUARY HEATHCOTE R.
A
FROM ESTUARY, HEATHCOTE, TO INNER CHAMBER OF MOA-BONE POINT CAVE NEAR SUMNER.
SCALE. 60 feet — 1 inch.
To Sumner
From Christchurch
MAIN CAVE
SECTION No. 1
SECTION No. 2
INNER CAVE
No. 2. Cross Section of Moa bone point Cave
PLAN OF MOA-BONE POINT CAVE NEAR SUMNER
SHEWING LINES OF SECTIONS.
REFERENCE
European bed.
Shell bed.
Blown sands
Dirt and ash bed.
Agglomeratic bed.
Marine sand
Recent estuary deposits.
Boulder banks.
To accompany Paper by Dr. Haast.

Before giving a description of the cave as I found it before beginning my labours I may observe that the same was well known from the very beginning of the Canterbury settlement. It was even inhabited by some of the earliest settlers, and for some time afterwards afforded shelter to lime-burners, fishermen, and road parties, of whom, as will be seen in the sequel, ample traces were left behind.

The entrance of the cave, which is about forty feet from the crown of the Sumner road, which has here an altitude of 18·59 feet above high-water mark, is situated nearly 5 feet lower, or 13·64 feet above high water, taking the level of the surface for our line.

An opening, which is about 30 feet broad by 8 feet high, being, however, much narrowed by a huge rock, leads into the cave, of which I found the floor slightly sloping down. The cave itself consists of three compartments, of which the first one possesses by far the greatest dimensions, running nearly due north and south, and being 102 feet long, 72 feet broad towards the middle, and about 24 feet high.

From its termination, by a small passage a second cave is reached, which is 18 feet long, 14 feet wide, and about 11 feet high; its direction being north by west to south by east; at its southern end a small passage, 3 feet high, by about 2·50 feet broad, leads into a third or inner chamber, which is 22 feet long, with an average width of 16 feet, and about 20 feet high, running again like the principal cave due north and south; its floor being about eight feet above high-water mark.

My best thanks are due to Mr. T. Roberts, the present engineer of the Gladstone and Timaru Board of Works, who, at my request, has taken the necessary levels and surveyed the cave, the result of his labours being attached to this report.

Contents of Cave.

An examination of the surface beds showed that the floor of the main cave was, in some localities, covered with the remains of European occupation, in many others by the excrements of goats and cattle, introduced into Canterbury by the Europeans in 1839; but that everywhere below them, when visible, portions of shells of mollusks were occurring, the same species as still inhabit the estuary close by, and had served as food to the natives of the islands visiting the cave in former times.

Towards the end of the main cave these beds gradually thinned out and were mixed with each other, till at the entrance to the second cave marine sands, the former floor of the cave, reached the surface.

So, proceeding with two labourers to the cave, I instructed them to dig two trenches, crossing each other at right angles, in the centre of the cave,

till they reached what they considered the lowest part of the deposits due to human agency. On 29th September, when arriving early in the morning, the greater portion of that work had been accomplished, the workmen having reached a bed of agglomerate, which they considered the bottom of the cave, for our purpose, or at least reaching to the earliest beginning of human occupancy.

Digging, by my direction, through this agglomerate for a considerable distance down into the sands below it without any proof of human presence being obtained, I also reluctantly, at least for the present, gave up any further work below it.

Sections Nos. 1 and 2 (Pl. I.) give the details of the excavations then performed. At the centre of the cave, where the two trenches crossed, I noted the following sequence :—

	Ft.	In.
1. Shell beds, consisting of the remains of the following species, now still inhabiting the estuary :—*Chione stutchburyi* (cockle) huai or pipi ; *Mesodesma chemnitzii*, pipi ; *Amphibola avellana* (periwinkle) hetikutiku ; *Mytilus smaragdinus* (mussel), kuku	1	10
2. Ash bed with some pieces of flax, cabbage tree leaves, charred wood, etc.	0	8
3. Bed consisting of shells, often very much decomposed, the same species as No. 1	1	2
4. Ash and dirt bed, with a few pieces of Moa bones	0	9
5. Agglomeratic beds, consisting of pieces of rocks fallen from the roof	0	6
This latter deposit rested upon	4	11

6. Marine sands, in which I had dug down 3 feet without results.

Between 3 and 4 a sharp line of demarcation was clearly visible, which, as the continuation of the excavations showed, was of great importance.

European beds do not appear as occurring on the surface at this point, as they had been previously cleared away by the workmen.

Near the entrance of the cave the following beds were passed in the longitudinal trench (see Pl. I., sec. 1).

	Ft.	In.
1. Beds of European occupation, cow-dung, tins, pieces of bottles, etc.	0	9
2. Shell beds	2	3
3. Ash beds	0	5
4. Shell beds	1	4
5. Ash beds, chips of wood, tussocks	0	6
6. Shell beds, often very much decomposed, with small chips of timber, and thin beds of ashes between them, about	3	0
(Lowest portion of No. 6 not reached.)	8	3

Owing to the depth of the trench at this spot the same was not continued. The spot where I noted this section was about 10 feet from the entrance of the cave. At the point where it reached the large rock, lying nearly across the entrance of the cave, the sequence was as follows :—

	Ft.	In.
1. Beds of European origin	0	7
2. Shell beds	2	1
3. Ash beds	0	6
4. Shell beds	1	4
5. Ash beds	0	9
6. Drift sands	1	0
7. Ash and dirt bed (lower series)	0	7
8. Agglomerate	0	5
	7	3

The shells in the beds were exactly of the same description as those given in the foregoing section at the junction of both trenches in the centre of the main cave. The sequence of the beds and this identity of species proved clearly that a native population, living principally upon the mollusks now inhabiting the estuary, have occupied every part of the cave during a very long period, that portion near the entrance being of course preferred; this accounts for the greater thickness of the beds in its immediate neighbourhood, which, as will be observed, gradually thin out as we advance towards the termination of the first cave.

Advancing to a consideration of the section exhibited in the cross trench, we find that it passes through the following beds on A—it's *eastern side*, (Pl. I., sec. 2):—

	Ft.	In.
1. European beds, consisting of wheaten straw, bones of butcher's meat, shells, match-boxes, horse dung ...	2	1
(Here was evidently a favourite spot for the cave-dwellers of European origin.)		
2. Ash bed, tussocks (Maori)	0	4
3. Shell beds, similar to those described previously ...	0	8
Lower Series.		
4. Ash and dirt beds	0	5
5. Agglomeratic beds	0	7
	4	1

Below 5, the marine sands were examined for about three feet down.

B.—*Western Side.*

	Ft.	In.
1. European beds, mostly cattle-dung	0	1
2. Shell beds, like No. 3 in previous enumeration ...	1	1
3. Ashes, tussocks, etc.	0	10
4. Shell beds, often much decomposed	0	9
5. Ash bed	0	4
6. Ditto, mixed with shells	0	9
Lower Series.		
7. Dirt and ash bed	0	3
8. Agglomeratic bed	0	5
	4	6

Marine sands proved to exist for about 3 feet below No. 8.

Beside the shells, of which the bivalves were with very few exceptions found only in single valves, pieces of wood (partly charred), portions of wooden implements of Maori manufacture, plaitings, made of *Phormium tenax*, and pieces of two broken polished stone implements, were collected, whilst close to the bottom of the trench a few Moa bones were obtained, amongst which several species were represented.

On the top of the dirt bed immediately above the agglomerate a small piece of a tibia of *Meionornis casuarinus*, bleached and much decomposed was observed by me, which had been lying close to a well-preserved seal bone, possessing the light brown colour the bones generally exhibited when exhumed, thus suggesting that the Moa bone must have been brought into the cave from the outside after having become bleached and partly decomposed.

In order to test more fully the general character of the beds above the agglomerate, I gave directions to the labourers to work backwards from the cross trench, examining first the south-west corner of the cave, once more cautioning them to use the utmost care, and not to hurry over the examination.

With this work we continued until 3rd October, when, after having looked carefully over the specimens obtained, I could not divest myself of the conviction that in and below the agglomeratic beds remains proving human occupation must be found.

Amongst the objects obtained during the last few days, the workmen having turned over deposits covering an area about 20 feet by 30 feet wide, and advancing in a south-west direction, were some Moa bones, the leg bones usually broken as for the extraction of the marrow, others of them calcined, and all of them occurring only in the lowest bed.

The overlying shell beds, as I shall call them in future, consisted principally of the usual remnants of shells, together with some seal bones belonging

to fur seal and sea leopard, portions of the Maori dog, all evidently from their kitchen middens; bones of fish, without exception, belonging to *Oligorus gigas*, the hapuku; also, bones of small birds, of which the enumeration will be found in the lists attached to this memoir; of the latter, those of *Graculus punctatus*, the spotted shag, were the most numerous.

Works of human industry were not wanting, as we obtained pieces of timber evidently worked and planed down by polished stone implements, and upon one of which a coating of red colour was still visible. Amongst the other objects made of wood hitherto exhumed were—

1. Several pieces of "toa," a thin and long wooden spear made of tawa (*Nesodaphne tawa*), a tree which grows only in the northern part of the Northern Island. This spear is used by the Maoris for shooting birds. For this purpose, they form, as it were, a short tube around it with the one hand, through which, after taking proper aim, they jerk the thin spear up suddenly with the other.

2. A patuaruhe, or fernroot beater, made of maire (*Santalum cunninghamii*), another strictly Northern Island tree.

3. The greatest portion of a whakakai, a wooden dish made of pukatea (*Atherosperma novæ-zealandiæ*), used for placing fat birds in so as not to lose the oil, or for the preparation of the juice of the tupakihi (*Coriaria ruscifolia*).

4. Several large pawa shells (*Haliotis iris*), in which the holes near the exterior border are filled with the fibres of flax or ti leaves, thus forming a vessel for the preservation of oil and other liquids.

5. A fishhook (*matoa*), used for catching hapuku, made from the wood of the kaikaiatua (*Rhabdothamnus solandri*) another Northern Island tree.

6. A long slender switch, of which part was broken off, and having at the other side a notch for tying. This is called a tokai made of aka, one of the *Metrosideros* or rata species. It is used to keep the entrance of a fishing net open.

7. Another piece was recognised as a takaorekaka—a parrot perch made of pukatea.

8. Several pieces belonging to a canoe, such as the puru (two specimens), made of manuka (*Leptospermum scoparium*), used to stop the holes in a large canoe, for letting the water out; and a square piece of wood, made of totara (*Podocarpus totara*), called tahatikiwhaka, used to fasten the sides of a canoe.

9. Also, portions of a matiha, or fighting spear, made of manuka, and several other wooden implements.*

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* I owe a great deal of this information to Hone Taahu and Tamati Ngakahu, two skilful Maori artificers of the Ngatiporou tribe, Poverty Bay, Northern Island, who, for some months past, have been occupied at the Canterbury Museum with the necessary preparations for the erection of a Maori house, carved and painted in the original style of ancient Maori art, now fast dying out. As they come from a part of New Zealand where the ancient native customs have been retained longest, their information may be considered very reliable.

However, besides the few pieces of Moa bones which might accidentally have been brought into the cave from the outside, there was nothing which could prove that there had been a regular occupation by the Moa hunters.

I therefore set the labourers to work to go through the agglomeratic bed once more, and I was delighted to find, very soon, that this time my expectations were not doomed to disappointment.

After having passed through that bed, which I found to be here 6 inches thick, another ash bed of a thickness of 3 inches was reached, in which I obtained several Moa bones, some of them calcined, others in a splendid state of preservation, belonging to *Euryapteryx rheides* and *Meionornis didiformis*, as well as some pieces of charred wood.

Proceeding with the utmost care, several large stones were reached covered with several inches of sand, some of them blackened or split by the action of fire, and placed in such a position as to show that evidently an oven had here been excavated in the sands, these stones, like the remains of the meal taken here, having probably been trampled repeatedly over, and before the ash and dirt beds had been deposited above them.

In digging round this spot I obtained the upper mandible of *Aptornis defossor* in a fine state of preservation, and a quantity of Moa bones, also two wooden sticks made of pukatea (*Atherosperma novæ-zealandiæ*) for producing fire. This simple apparatus, the only one found in the cave, has the peculiarity that fire, instead of being obtained by friction lengthwise, was procured by giving the upper stick a turning motion.

However, I may add that this was not the only mode by which the Moa hunting population obtained fire, as in the same lower beds firesticks of the other kind were also found, resembling, in this respect, those belonging to the upper or mollusk eating population, which are used at the present time by the Maoris, and are called kauwahi by them.

About 4 feet from this oven we came across some large pieces of egg-shells, of which many had still the lining membrane attached, proving, by their form of curvature, that they were portions of a *Dinornis* egg of very large size.

Towards the western side of the cave, partly buried in the sands, partly in the ash-bed below the agglomerate, a well preserved skull of a fur seal, probably *Arctocephalus lobatus*, was obtained.

Having been so far successful, I had the sea sands examined over a considerable space, and to a depth of seven feet, when water was reached. Since then I have been boring near the same spot, and found that the sea sands continued for another 5 feet before the rock on the bottom of the cave was reached, thus showing that there is here a total thickness of 12 feet of marine sands in the cave.

The following shells were obtained in these sands, without doubt brought with them into the cave by the waves of the sea, viz. :—*Mactra discors*, *M. donaciformis*, *Mesodesma cuneata*, *Artemis subrosea*, *Turritella rosea*, and fragments of some others, but no estuary shells.

Section No. 3 (Pl. II.) gives the details of this important point. On the surface we found:—

	Ft.	In.
1. European deposits, dung of cows, goats, etc., wheaten straw, ashes	0	6
2. Shell bed (Maori)	0	9
3. Tussock and ash beds	0	4
4. Shell beds	1	4
5. Ash beds	0	2
6. Ditto, mixed greatly with shells, often very much decomposed	0	10
7. Ash and dirt beds (lower series)	0	2
8. Agglomeratic bed	0	6
9. Ash bed	0	3
10. Marine sands to water	7	0
	11	10

Amongst the shell beds, blocks of rocks, often of large size, were met with, evidently fallen down from the roof, showing that since the formation of the agglomerate bed the cave continued to be still insecure.

There was thus conclusive evidence of the Moa-hunters having used the cave occasionally as a cooking place; whilst the absence of any shells proved, as I shall also show, when speaking of the numerous Moa ovens amongst the small hillocks of drift sand near the entrance of the cave, that the population who exterminated our huge birds did not look with a favourable eye upon the food, used almost exclusively by their successors, supposing that they could have easily collected it.

However, I may here observe, that near the oven in question, a few valves of our common freshwater mussel (*Unio aucklandicus*) were obtained, which must have been brought by the Moa-hunters into the cave.

For the next few days we continued to excavate towards the end of the main cave, where, near the entrance to the small middle chamber the marine sands sometimes reached the surface, European, Maori, and Moa-hunter remains being here occasionally mixed with each other, trodden down into the sands by men or cattle. In a few more protected spots, ash and dirt beds, to a thickness of several inches, remained undisturbed above these sands.

Advancing from the entrance to the middle chamber towards the big fragment of rock B, fallen from the roof, which is 6 feet broad by 12 feet long and

10 feet high, and forms a remarkable feature in the cave, the artificial deposits soon became more considerable and full of interest. Close to the rock, on its southern side, they reached a thickness of nearly 3 feet, consisting of—

	Ft.	In.
1. Beds of European occupation (cow-dung)	0	4
2. Shell beds (Maori)	0	10
3. Dirt and ash beds, with tussocks and flax	0	4
4. Shell beds	0	9
5. Lower series, dirt and ash bed	0	5
6. Agglomerate bed, altering gradually again to ash bed upon the sands	0	3
7. Marine sands as far as excavated	3	0
	5	11

In the lowest beds, partly imbedded in the sands, we obtained a great number of Moa bones, belonging at least to six specimens, of which four were well represented, namely, three specimens of *Meionornis didiformis*, of which two were immature birds, and one specimen of *Euryapteryx rheides*, also not yet full-grown.

Advancing towards the huge rock previously alluded to, I observed that one portion of its unequal under surface stood above the sands, thus leaving a space below, from which we took a number of things, amongst them a fine and perfect pelvis, and several leg bones of an immature specimen of *Meionornis didiformis*, some bones of the Maori dog, like the former, partly calcined and broken, having been used for food, as well as portions of skeletons of shags, penguins, and some other birds.

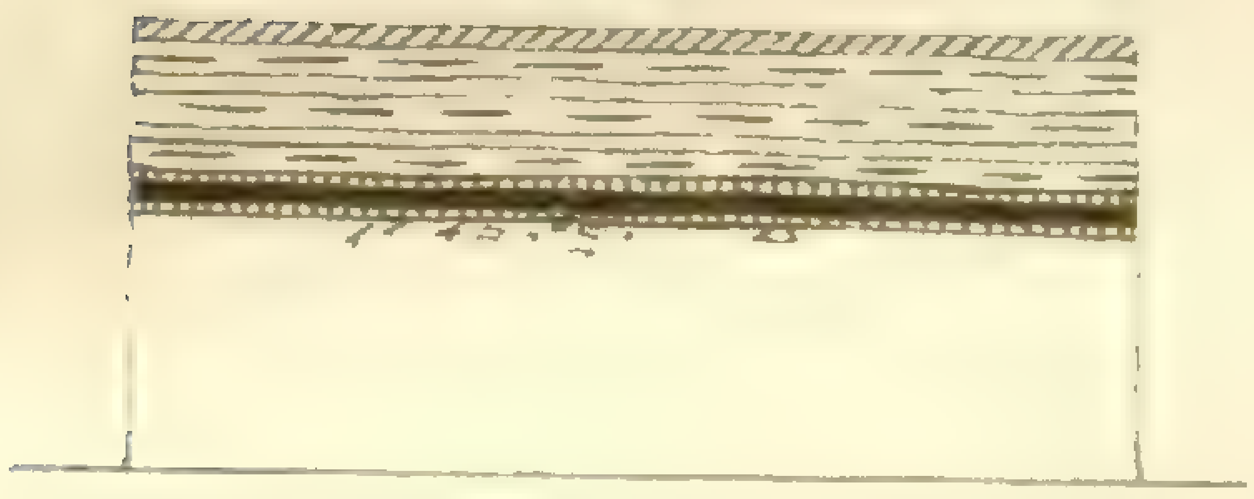
When examining the shell beds we had repeatedly found amongst them match boxes, small bones of sheep, and other remnants of European life, evidently brought into their present position by means of numerous rat holes passing through these upper beds; also near to this inconsiderable spot not filled up by the sea sands a few small European remains had found their way, which, if the mode of their transport had not been clear to me might have been a great puzzle.

Section No. 4 (Pl. II.) gives the details of the arrangement of the beds abutting against the rock. Also a considerable amount of drift timber was lying here, without doubt mostly brought so far back by human agency; a great deal of it being charred, or partly burnt; and all the evidence before me went to show that this spot, hidden as it was from the entrance by the huge rock in front of it, had been a favourite camping and eating ground, both of the Moa-hunting and afterwards of the shell fish-eating populations.

For another week I continued to occupy the workmen in the south-eastern

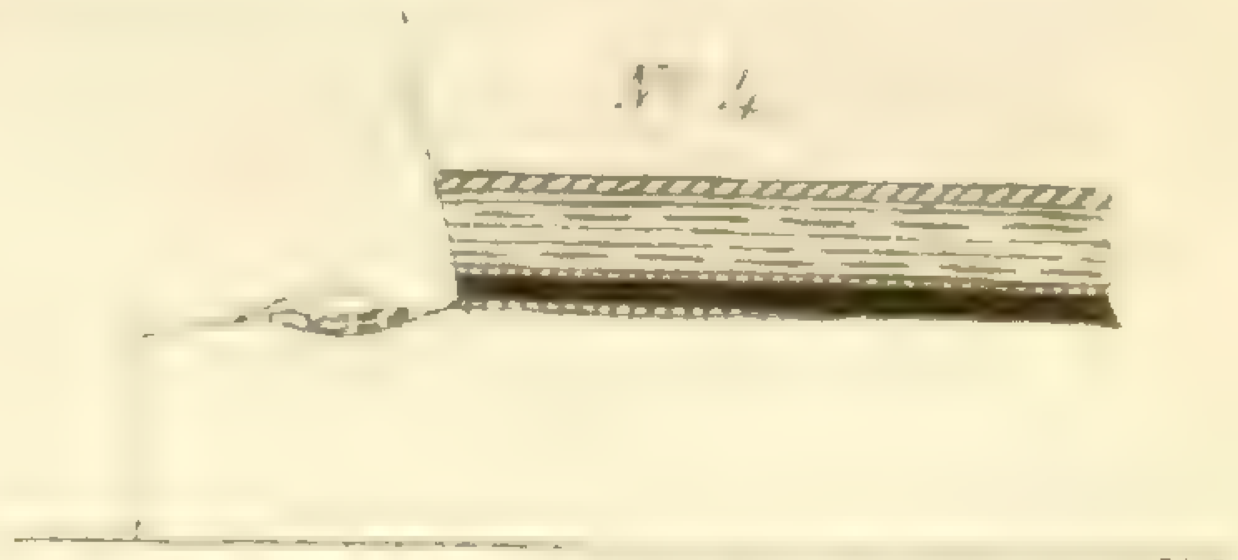
MAP
OF NORTHERN FOOT OF BANKS PENINSULA.

No 3.



SECTION IN SOUTH-WESTERN SIDE OF CAVE.
E. & W.

No 4.

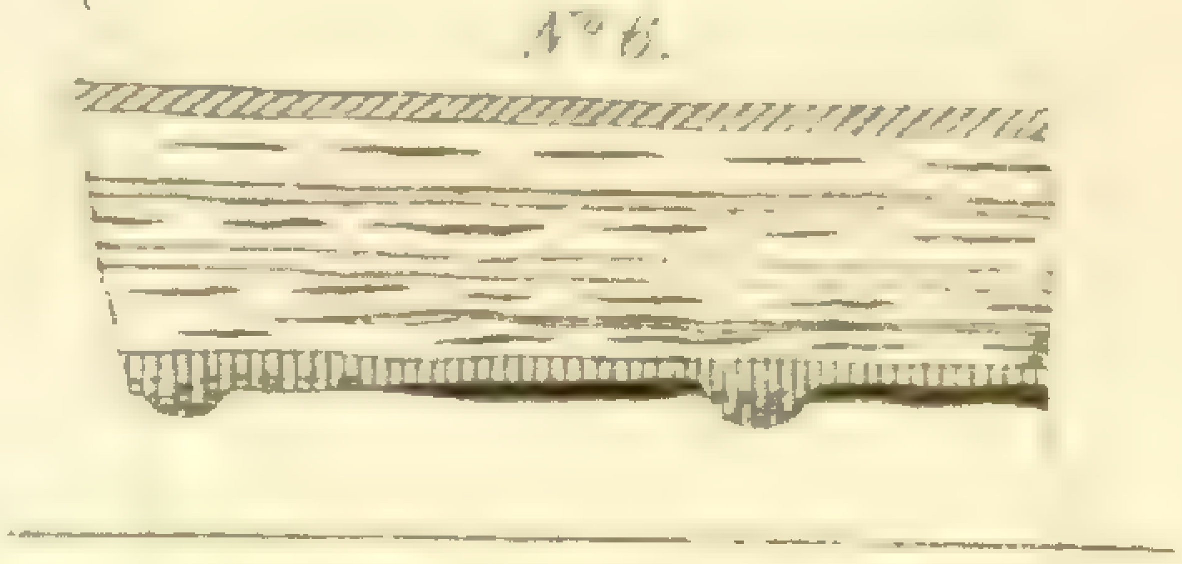


SECTION IN SOUTH-EASTERN CORNER NEAR ROCK B.
N. & S.

No 5.

SECTION IN SOUTH-WESTERN CORNER OF CAVE, WITH MAORI GRAVE.
E. & W.

No 6.

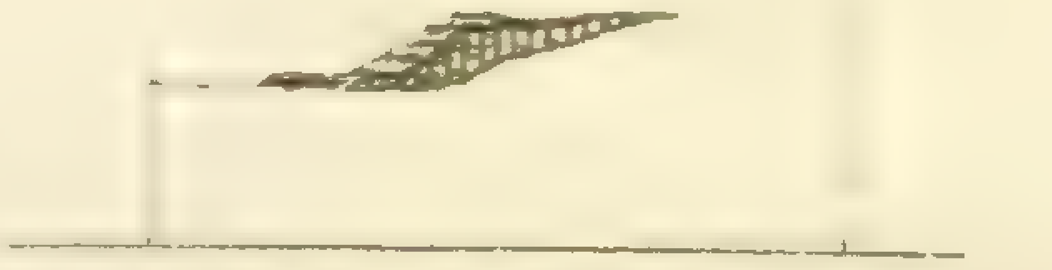


SECTION NEAR ENTRANCE.
E & W.

No 7.

SECTION ON SAND-DUNES NEAR SUMNER CAVE.

No 8.



SECTION ON SAND-DUNES NEAR SUMNER CAVE.

To accompany Paper by Dr Haast, on Sumner Cave Excavations.
Scale of Sections, Nos 3. to 8. 20 Feet = 1 inch.

portion of the cave, but gradually advancing towards the western side of the cross trench of which section No. 2 (Pl. I.) gives the details.

Before reaching the trench at the spot marked C in the ground plan of the cave (Pl. I.), we came across a stand having been used for the stabling of a horse, which had been dug into the shell-bed to a depth of several feet; in some spots reaching actually down to the marine sands.

This strange place for a stable was now mostly filled with horse-dung and European kitchen middens, well trampled down, and above them, with a layer of the excrements of cattle.

Altogether, in this part of the cave, the beds had been much disturbed by the cave-dwellers of European origin, so that in some instances Moa bones were actually mixed up with bones of butcher's meat, lying now together in disturbed shell beds.

When advancing towards the point where the two main branches crossed each other, the workmen observed, standing vertically in the sands, the remains of two much decomposed piles, having a diameter of about eight inches, and which apparently had been deprived of their bark by means of a smooth stone implement, before having been placed in their present position.

Evidently they had been burned to the ground before the lowest dirt bed had been deposited, their charred ends standing scarcely above the level of the marine sands.

Of these piles, the first was observed 15 feet from the eastern wall of the cave, and 6 feet behind the cross trench, the second opposite to the first on its south-western side, and at a distance of 12 feet.

They were found during my absence, and the men not thinking their occurrence of sufficient interest, simply took them out—but noting their position—instead of leaving them standing until I came down. They reported that they had reached about 16 inches down into the sands.

During my presence I caused new excavations to be made round the spot where these piles were reported to have stood, but I could not get any other object except portions of one of the piles, which on examination proved to be rimu (*Dacrydium cupressinum*).

In the agglomeratic bed in this south-eastern portion of the cave we obtained a number of Moa bones, of which portions of a skeleton of *Euryapteryx rheides* were the most conspicuous. With the latter also the two rami of the lower mandible were found, but not the least portion of the skull; in fact, the absence of any but very small fragments of skulls in all kitchen middens shows that the brain of the Moa was considered a great delicacy.

Here we got again a few small pieces of obsidian and some chips and cores

of flint together with similar rough and primitive tools made of a hard and compact dolerite found *in situ* close to the cave.

In the lower beds also seal bones, a few phalanges from the flipper of a small whale, and bones of birds still at present inhabiting New Zealand, were collected; amongst the latter those of the spotted shag and small blue penguin were most numerous.

In the dirt and ash bed above the agglomerate, we obtained a number of bones belonging both to our extinct and living vertebrate fauna, amongst them the greater portion of the skeleton of a fur seal. In the shell beds above numerous Maori remains were found, amongst them a few fernroot beaters, made of wood, some canoe pins, flax-plaitings, all of which will be enumerated in the appendix C.

When examining first the two main trial trenches crossing each other at right angles in the centre of the cave, the absence of the agglomeratic beds was here noted by me, but I then thought that it might have been caused by the roof having—in that part of the cave—accidentally possessed a greater solidity.

In this surmise I was still more confirmed by finding that in those spots the dirt and ash bed was much thicker, lying here directly upon the sands, so that the former had a nearly uniform upper surface.

However, when continuing the excavations across the cross ditch towards the entrance of the cave, to the description of which I shall devote another portion of this memoir, we found in the longitudinal trench a third pile, and observed that in the space between these three points and another point, where, however no remains of a pile were existing, forming an oblong square 36 feet long by 12 feet wide, the agglomerate bed was entirely missing, and the inference was therefore natural that at some time a human dwelling of some kind had been standing here.

My first impression was that the cave dwellers, in order to protect themselves from the pieces of rock becoming loosened at intervals from the ceiling, had built a strong roof, resting upon four corner piles, which, after the principal fall of rocks ceased, had accidentally been burned to the ground, but on closer examination it became clear to me that the time during which the agglomeratic beds were formed was of such long duration that it is impossible to assume such a frail construction having lasted so long. Moreover, one can scarcely believe that a primitive race, and which evidently only at intervals inhabited the cave before the agglomerate bed was deposited upon the marine sands, should act with such forethought and care.

There remains only one other explanation, which I advance with some diffidence, namely, that the builder of the dwelling, whoever he may have been,

excavated not only the four holes for fixing the corner piles into the agglomerate, but actually lifted the same in the space between them; against this, however, it may be observed that if such, as we may presume, unnecessary work was performed, the agglomerate bed ought not only to end abruptly round the former dwelling, but that the removed material, having been thrown outside, the thickness of the bed in question ought to be here much more considerable.

However, from the sections made during the progress of the excavations, it does not appear that the agglomerate bed was generally thicker outside this oblong square, or that it ended abruptly. On the contrary, the same was found to thin out generally close to the intersecting lines, the ash and dirt bed becoming gradually thicker. The same was the case in some of the other portions of the cave, where the agglomerate was also occasionally missing, and I can only regret that when that portion of the cave towards the entrance was excavated, where a great thickness of the overlying shell beds had first to be removed, my official work at the Museum would not allow me to go so often to the ground as I should have wished. This question has, therefore, to remain an open one.

Having reached (Saturday, 19th October) the cross trench on the eastern side of the cave, and thus examined the whole south-eastern portion, I began to continue with the excavations on the south-western side towards the termination of the cave in that direction.

Hitherto we had not been successful either in obtaining human bones, or Maori objects of any value, which I hoped might have been placed in a cache similar to those found in carefully excavated hiding places in the Moa-hunter (and afterward Maori) encampments at the Rakaia. However, that evening we came a few feet from the south-western wall upon disturbed ground, and carefully taking off the material, the skeleton of a Maori was reached, who as section No. 5 (Pl. II.) shows, had been buried a considerable time.

The aborigines who had placed the body there, had dug through the shell-bed for about 8 inches, then 2 inches through the dirt and ash bed belonging to the older series, and 4 inches through the agglomeratic deposit.

They had then excavated the marine sands for several feet, and had placed the corpse in a sitting position in the grave thus formed, tied together with flax, the face towards the wall of rock, covering it with part of the sands thrown out, the rest being thrown with the shells excavated around the spot.

However, it was clearly visible that the ground had afterwards been levelled, as it were, under the feet of human occupants, and about six inches of newly-formed shell-bed, being continuous and level with the more distant

layer of the same nature, had been deposited over the grave, the whole being capped with 3 inches of European accumulations.

It is thus evident that the burial had not only taken place long before the Europeans came to the cave, but that the Maoris continued for a considerable number of years to frequent the cave, and to take their meals there after that event had happened.

This fact naturally leads me to conclude that the cave was not constantly, or even regularly, visited by the Maoris; and that its occupation occurred only occasionally, and by different tribes of natives; because, judging from the character and superstitions of the aborigines of the present time, we can safely say that, after the burial of one of them, the cave would have become strictly tapu to all those having any knowledge of the fact, at least as far as the taking of meals is concerned.

This opinion is also shared by the Rev. J. Buller, whom I consulted on this question, and who, having been living for many years amongst them in the Northern Island, is perfectly acquainted with all their customs.

From this fact alone, and the conclusions therefrom, if admitted, we are obliged to assume that considerable space of time was necessary to form this shell bed alone.

The body, as before observed, had been tied together with flax, the knees being placed below the chin. Owing to the antiseptic properties of the sand, there were still some ligaments and skin upon the bones, and some hair upon the skull.

The skeleton which has been articulated by Mr. F. Fuller, and now stands in the Canterbury Museum, belongs to a man of a height of nearly 6 feet, past manhood. The ulna of the left arm is broken, and was only partially healed when the man died.

We are so accustomed to observe natives possessing a fine set of teeth that it is rather striking to see that this aborigine must have suffered very much from bad and distorted teeth.

Thus we find that most of the premolars and molars are missing in the lower jaw, the alveoles being already quite absorbed. In the upper jaw, the first molar on the right side, and the first molar on the left are distorted inwards, their anterior surfaces being adherent to the alveoles, which are developed into a slight bony outgrowth. Owing to a very remarkable distortion of the left molar, mastication was performed with its outer surface, which was worn.

Examining the two smaller caves, we obtained here some Moa and other birds' bones lying close to the surface of the sands, mixed up with ashes and other signs of human occupation, so that it is evident that casual visitors

penetrated to these inner caves, probably to hide themselves from their enemies, and cooked their meals, or at least lighted fires.

As these two smaller caves for years past have been visited by Europeans, a number of Moa bones have, as I understand, been carried away, having been observed amongst the sands.

Having reached the end of the main cave, a more tedious piece of work was now before us, because before being able to reach the dirt and agglomerate beds in this northern portion of the cave, we were obliged to remove a considerable mass of shell deposits, which, as we approached the entrance of the cave, became gradually thicker till they reached a thickness of 8 feet.

I have already before stated that the agglomerate bed was missing where the supposed hut or enclosure had once been standing, and that the ash and dirt bed continued without interruption to cover here the marine sands.

Over this area I observed the dirt bed to possess a much greater thickness than in other localities where the agglomerate was present, attaining generally a thickness of 8 to 9 inches between the four piles, and thus showing that by a more extended deposition of ashes and kitchen middens, the general level of the floor of the cave had here been maintained.

We obtained here, mostly embedded in the marine sands and only partly entering the dirt bed, the bones of the left leg belonging to a large specimen of *Euryapteryx gravis.* The tibia and femur had been broken in the usual manner for the extraction of the marrow, whilst the metatarsus was entire, and very much calcined at its lower (distal) extremity. The fibula was found to be also broken in several places, as would happen by fracturing the tibia, with the former bone still attached. Some phalanges and a great number of small pieces of the two broken leg-bones were lying also close by.

As none of the bones were calcined, with the exception of the lower portion of the metatarsus, it appears that this part, not possessing any flesh, was not protected from the fire so carefully as the other portions had been.

If this surmise be correct, we have here a case of broiling on a large scale before us.

Advancing towards the entrance of the cave, we obtained occasionally in the marine sands, agglomerate and dirt beds, rough stone implements, mostly mere chips of dolerite, obtainable close to the cave, and with very few exceptions, in no way to be compared with the artistically chipped flint implements from the Rakaia encampment; but these shapeless implements were now sometimes replaced by better formed tools. Some pieces of obsidian were found with them, embedded in the agglomerate, having, in two instances, the form of spear heads.

From the great number of Moa bones belonging to so many specimens and

species found over that small area it became evident that this spot had been a favourite camping ground for the Moa-hunting frequenters of the cave, because in the small space between the northern side of the supposed enclosure or hut, and the entrance of the cave, we obtained the following bones:—

Of Dinornis robustus.

Right femur, portions of tibia and metatarsus (broken for the extraction of the marrow) portion of pelvis, two ribs, four cervical and one dorsal vertebræ.

Of Palapteryx crassus.

Portions of two full-grown birds, femora, ribs and several vertebræ.

Of Euryapteryx gravis.

Portions of right femur, of pelvis, two ribs, nine phalanges, one dorsal, three cervical vertebræ, all the bones of this specimen being doubtless derived from the same individual to which the bones of the left leg belonged, previously described, and which were found towards the centre of the cave.

Of Euryapteryx rheides.

Numerous bones, belonging to at least two adults, and one young specimen, the leg bones broken in the usual manner, portions of pelvis, sternum and skull, vertebræ, phalanges, and ribs in considerable number.

Of Aptornis otidiformis.

Lower portion of left tibia and femur, the marrow having evidently been extracted.

Besides these remains, belonging to our extinct birds, a great number of bones of smaller species of our recent Avifauna were collected, of which *Graculus punctatus* (the spotted shag) and *Eudyptula undina* (the small blue penguin) were the most numerous. Besides them, other species of the *Graculus* family, the grey duck (*Anas superciliosa*) and gulls and terns were well represented. From the dirt beds a considerable number of feathers were collected, mostly belonging to the spotted shag, but none which could be identified as Moa feathers.

In the upper, or shell beds, as previously stated, the bones of the spotted shag were also of frequent occurrence, and besides those previously enumerated, we found also a few belonging to the white crane, the nelly, and the New Zealand harrier. The feathers collected in these upper beds were mostly all belonging either to the spotted shag or to the kakapo (*Stringops habroptilus*).

It may not be here out of place to remind you that amongst the kitchen middens of the Rakaia encampment, belonging to hundreds of specimens, only a few bones of *Dinornis ingens* were found, the more gigantic species being thus unrepresented.

It is therefore interesting to observe that the Moa-hunters were also chasing the latter, as proved by the remains of *Dinornis robustus* in the kitchen middens at the mouth of the cave.

In the sands at the western corner near its entrance, and where, as before observed, the agglomeratic deposit was missing, we found arranged in the sands another oven of considerable dimensions, used for a time by the Moa hunters, but afterwards abandoned, as it was filled and covered over with numerous Moa bones and their fragments, as well as with a considerable thickness of dirt and ashes.

The absence of ovens for cooking purposes, with the exception of the one previously alluded to occurring in the marine sands in the south-western portion, and of the second at the western entrance of the cave, together with a third—of which I shall speak presently—is a striking feature from which we can only conclude that the Moa-hunters cooked their food generally outside, and only occasionally eat it inside the cave, whilst the thick ash bed suggests that generally fires had been lighted, round which they sat or camped.

The third oven—several feet in diameter—was found about 10 feet from the entrance towards its middle part, having been prepared immediately after the agglomeratic bed had been deposited.

The Moa-hunters had broken through that latter deposit, and arranged the stones of their oven, taken mostly from the removed agglomerate in the marine sands thus laid open.

After having been used probably in a few instances only, it had become filled up with some of the agglomerate, previously disturbed for its excavation, not used for cooking purposes, with pieces of Moa bones and chips of timber (totara). Some of the latter were standing vertical, or at least at a high angle, whilst the chips amongst the dirt beds were found to be generally in a horizontal position.

This oven, with the kitchen middens filling it, was found to be covered by the never missing ash and dirt bed, the latter being continuous with the same deposit all round.

It is thus evident that this oven was excavated, used and filled again with the remnants of the meals, and of the usual occupations of the Moa-hunters before the ash and dirt bed was formed above the agglomerate. On the bottom of this oven a polished chisel of dark chert was discovered, 4·8 inches long by 1·51 inches broad, which in its general form resembles those which are doubtless of Maori manufacture, and which probably had been lost accidentally by being covered over. I obtained the information concerning this oven from the workmen, as I was unfortunately absent when the discovery was made,

but I think it can be accepted as reliable, as I cross-examined both men, and found their account to agree in every particular.

However, to strengthen this important point, on the 31st October, during my presence, the men picked up a portion of another polished adze, which fell out of the face of the agglomerate bed, just broken into, and when examining that face carefully I had the satisfaction to find the spot whence it had fallen out, so that there is no doubt but that it had been embedded in that agglomerate.

On the other hand, in the dirt bed near the entrance of the cave, generally close to the agglomerate, or when missing, sometimes in contact with the marine sands, several broken polished stone implements were excavated, together with pieces of gritty sandstone, some of which had been grooved during the process of sharpening.

As these fragments were found amongst the undisturbed kitchen middens of the Moa-hunters, there is not the least doubt that the same were possessed of polished stone implements, as well as of chipped flint tools, probably employing the former for the building of their dwellings, or manufacture of their canoes and wooden implements, whilst the latter were probably used for the chase or for cutting up and preparing their huge game for the oven and their meals. And as I shall show further on in the description of the numerous Moa ovens outside the cave, that similar polished stone implements were obtained in contact with Moa bones in undisturbed positions, I have to modify my former views in assuming that the Moa-hunters did not possess polished stone implements. Thus the excavations in and near the Moa-bone Point Cave fully confirm the observations concerning this point made, and published by Messrs. Mantell and Murison some years ago.

My former opinion was based upon the careful examination of hundreds of Moa-cooking ovens in the Rakaia encampment, where I obtained great quantities of chipped stone implements, some of them remarkably well shaped, amongst the kitchen middens of the Moa-hunters, but in the same deposits never any polished ones, and as the latter were mostly found in deep câches, and the locality had been, according to Maori tradition, a favourite encampment of theirs, it was natural to be led to the conclusion that the few polished stone implements turned up here and there by the plough were like the câches of later (Maori) origin.

Section No. 6 gives the details of the beds, with the two ovens near the entrance of the cave.

Having determined that the beds were perfectly undisturbed, with the exception of the few cases already alluded to, it was of great importance to ascertain if, besides the stone implements found amongst the kitchen middens

of the Moa-hunters, no other objects of human workmanship were associated with them, in order to gain some more insight into the daily life of that primitive people.

However, if we consider that the cave was only occasionally frequented, we could not expect to find many objects of that nature, unless a fortunate accident had preserved to us some of their more valued utensils and ornaments; and although I was rather disappointed in that respect, the few objects found proved sufficiently that the Moa-hunters made their domestic tools neatly, as is generally the custom of primitive races.

In the dirt bed above the agglomerate in the anterior portion of the cave we obtained a needle 4·25 inches long by 0·20 inches broad, neatly finished, made of the humerus of a nelly (*Ossifraga gigantea*), and bodkin made of the distal portion of the tibia of the same bird, doubtless used for making holes through which the needle was passed afterwards; also, the canine tooth of a dog, with a hole bored through it at its base, worn without doubt as an ornament.

Amongst the pieces of wood collected from the lower beds, there is an apparatus for kindling fire, made of *Carpodetus serratus* (komaku), the fire to be obtained by rubbing the stick lengthwise on the other flat piece, several fragments of worked timber, firesticks, portions of spears and of canoes, the whole being so soft when excavated that it could easily be cut by the finger nail.

In appendix B a list of all the objects found is given, so that I need not particularise any other here.

The curious fact first observed at the Rakaia encampment that none of the bones of the kitchen middens were gnawed by dogs, was also recognised in and near the cave, the smallest bones, without exception, being quite intact, except where cut or broken by human hands.

On the other hand, in the upper or shell beds, many of the bones appeared to have been gnawed by rats and a few by dogs.

In any case, the hypothesis first put forward in my paper on the Rakaia encampment, that the Moa-hunters chased the dog for food, without having it domesticated, certainly gains by these new observations in probability.

Amongst the smaller birds enumerated in the appendix, of which none are extinct, the presence of the bones of the kakapo (*Stringops habroptilus*) and of the large kiwi or roa (*Apteryx australis*) proves that these birds inhabited the peninsula and its neighbourhood from where they have now disappeared a long time. The only fish bones obtained in the lower beds belonged, mostly all, to the hapuku (*Oligorus gigas*).

The upper or shell beds also did not contain any objects of value, which

had belonged to the Maoris, although, as appendix C will show, a great number of things were found, either broken, become useless and thrown away, or accidentally dropped.

There were only a few pieces of broken polished stone inplements and a small piece of nephrite (greenstone) amongst them.

Concerning the existence of human bones in the lower beds, I may here add that portions of the right ramus of a lower jaw were found in the western side in the marine sands, about 6 inches below their surface, which might have been carried in by the surf, as near it the greater portion of the skeleton of a fur seal was excavated, which was doubtless brought in in the same manner. This lower jaw had belonged to a not quite full-grown man, the last molar just making its appearance; there was not the least sign of such bones either in the agglomerate nor in the ash and dirt bed above it, thus confirming similar observations made at the Rakaia encampment.

Amongst the bones collected in the Maori or shell beds were two pelvic bones belonging to a full grown male, and the ninth dorsal vertebra, not quite mature; all three were entire, and it is difficult to say how they may have been brought into the cave, but as there was through the whole thickness of these beds not the least sign of any broken human bone, it appears obvious that during all the time the shell-fish eaters were in occupation of the ground they were either not cannibals, or had such a peaceful existence, not being at war with neighbouring tribes, that they had no opportunity to indulge in that horrible practice.

However, looking at the long lapse of time during which the shell-fish eaters were in possession of the ground, and the insecurity of life to which savage tribes are exposed, I am inclined to believe that had they been cannibals, when the lower portions of the shell beds were formed, there would certainly be some evidence of it.

My friend, the Rev. J. W. Stack, at my request, has made inquiries amongst the older natives in Kaiapoi, and has been informed by them that the cave in question had been a common resort of their fishing parties some thirty years ago, so that some of the uppermost beds might have been formed by their refuse; but as cannibalism has been practised at least for several centuries in New Zealand, the absence of human bones in the shell beds certainly proves that they are of considerable antiquity, which is still more strengthened by the curious fact that amongst the hundreds of bones belonging to small birds, not a vestige of the weka (*Ocydromus australis*) has been met with, the same being the fact with the lower or Moa-hunter beds, a feature they have in common with those occurring in the Rakaia encampment.

As far back as the traditions of the Maoris go, allusion is made in their

songs to the weka, and if we would examine newer refuse heaps of the natives, either on the coast or inland, I am sure that we could obtain ample evidence from the presence of the remains of this bird that it constituted one of their favourite meals.

I have before observed that the line of demarcation between the surface of the dirt bed and the overlying shell beds, in which no Moa bones were found, is constant and very distinct, and goes far to prove that during a considerable lapse of time no human occupation of the cave took place.

This proposition gains in strength by the existence of a bed of drift sand, deposited between these two beds, forming a layer of a thickness of about 12 inches at the entrance of the cave and gradually thinning towards the interior.

As the cave was amply protected, not only by its position as well as by the huge rock in front, but without doubt, also by dense vegetation, sprung up when it was left undisturbed, after the Moa-hunters ceased to frequent it, the discovery of this bed of drift sand between the two formations has important bearings.

Excavations amongst the Sand Hills outside the Cave.

Before proceeding to general conclusions to be drawn from the results obtained during the excavations in the cave in question, I wish to offer a short description of my researches, of which some date as far back as 1865, made amongst the Moa-hunters and Maori kitchen middens in its immediate neighbourhood.

When speaking of the position of the cave, I alluded already to the two lines of boulder deposits running from the western headland in an easterly direction, and gradually diminishing in height and size.

Between them and the foot of Banks Peninsula, near the cave, drift sands very soon accumulated, by which a quarter of a mile to the east these boulders were gradually covered.

About 200 feet east of the cave, Banks Peninsula recedes nearly a quarter of a mile to the south, the low ground being here also covered by drift sands, many acres in extent, the highest points 30 feet above high-water mark.

On this flat, first the Moa-hunters, and afterwards their successors, the shell-fish eaters, had extensive camping grounds.

Although in many places the kitchen middens of the older and newer occupants, owing to the changeable nature of the shifting sands, have become mixed up so as in many cases to make it impossible to fix a clear line of demarcation between them ; in other instances that peculiarity of the sands has caused that they have been very well preserved, and the space between both sets of beds sharply defined.

In the first instance we find that the Moa-hunters had numerous cooking places amongst these dunes, situated often closely together, which after use became filled up to some extent by the refuse of their feasts, whilst very often a larger heap of broken bones, egg-shells, etc., had been thrown a few feet from the oven, an observation made also at the Rakaia.

The following sections from that locality will, better than words can do, convey a clear insight into their principal features.

Section 7 (Pl. II.) taken about 4 chains from the entrance of the cave, and 1 chain north of the Sumner road, proves clearly that there exists a clear line of demarcation between the Moa-hunters' and shell-fish eaters' deposits.

After examining a bed on the surface, which contained the same species of shells as we obtained from the upper deposits of the cave, I had the sands below them excavated for about 2 feet, when we came upon the remains of a cooking oven, big boulders, charcoal, and near and above it a distinct layer of kitchen middens, which consisted of Moa-bones, the larger ones all broken, and some of them calcined; there were also some of smaller birds, of which those of the spotted shag (*Graculus punctatus*) were the most numerous; the crested penguin, the large kiwi, and the grey duck being also represented.

Besides them, bones of the dog, which appears to have been also a favourite dish of the Moa-hunter, a tympanic bone of a ziphoid whale and some seal bones were obtained.

Section 8 (Pl. II.), on the other hand, shows convincingly how in many instances the intermixture of the two series of kitchen middens has taken place. It is evident that in that locality, without doubt by rain and wind, a portion of the dunes upon which the refuse heap of the Moa-hunters had been deposited, had become partly destroyed, and that the same spot had afterwards been used as a camping ground by the shell-fish eaters, their kitchen middens having been thrown over the side into a hollow, thus covering as it were unconformably the former deposits of human occupancy.

In none of the clearly defined refuse deposits of the Moa-hunters were any marine shells found, but in one locality a few pieces of our fresh-water mussel (*Unio aucklandicus*) were discovered, probably used for domestic purposes, but, as before observed, in many instances the line between both series could not be drawn, and it appeared clear that the sands having been blown away, the kitchen middens of the older and newer occupants became not only intermixed, but even that the same boulders which were collected for their ovens by the Moa-hunters might have been used by the shell-fish eating population also.

Owing to the great extent of the area, it was utterly impossible to open up all the ovens occurring there, as this would have been beyond the means at

my command; however, sufficient ground was examined to show that the smaller species, *Meionornis didiformis* and *Euryapteryx rheides* were obtained most frequently, whilst *Euryapterix gravis* was also well represented.

Of *Meionornis casuarinus*, which was the most numerous species at the Rakaia encampment, only a few bones were observed both in the cave and on the sand hills, which suggests that in the hunting grounds, where the older occupants of that locality obtained their food, this species, so very plentiful near the Rakaia, must have been of rare occurrence.

Portions of the shells of several Moa-eggs were also collected, of which the greater part of one was lying on the surface close to the Sumner road.

The seal bones found so numerously in the older kitchen middens belong to several species, of which the larger fur seal is best represented, the small fur seal not being so frequent.

As will be gathered from the accompanying list, I obtained numerous stone implements, of which three adzes in good preservation were polished, and fragments of eleven others, together with nine pieces of gritty sandstone, used for sharpening or polishing. Of the former, one of the specimens was found immediately above the stones having formed one of the ovens, the others being scattered amongst the kitchen middens, and as this occurrence is a confirmation of the observations made in the cave, there is no doubt that the Moa-hunters used both polished and unpolished stone implements.

A number of small pieces of obsidian were also found, of which some were probably used as spear heads. Most of the rude chipped stone implements, like those collected in the cave, had been made from the basaltic rock in the neighbourhood, most of them were simply flakes without any decided form, but amongst them I observed a few manufactured for spear heads; others had evidently been chipped to be used as knives or scrapers, the rest being cores only.

Flint implements, so well represented at the Rakaia, were also not missing, but with the exception of about a dozen, which were either used as spear heads or knives, the rest were flakes or cores.

Of the remarkable green siliceous deposit (*Palla*) found in the Gawler's Downs, two small flakes were also amongst the specimens here collected. Two pieces of Moa-bones, partly worked, were secured, having doubtless been in preparation for the manufacture of fish-hooks, with them two ornaments made of the humerus of an albatross were found, neatly cut off to a length of about 1 inch, and resembling the heitikis used by the Maoris, in which the feathers of the tui, or small birds are inserted, and suspended from the neck. As already stated, we picked up also some tympanic bones of whales amongst the refuse heaps, so that it is evident that the use of this bone, for some purpose,

at present unknown to us, was universal amongst the Moa-hunters in this part of the country.

Judging from the great amount of kitchen middens deposited on the very small portion on the dunes examined by me, there is no doubt that the real camping ground of the Moa-hunters was outside the cave, and that they used the latter only occasionally for shelter, or for their meals, and only in a few instances for cooking purposes, thus proving that a long lapse of time was necessary for the formation of the lower beds alone. On the other hand, the observations I was able to make at the junction of the kitchen middens of the Moa-hunters and of the shell-fish eaters, demonstrates that there passed again a considerable time before the latter appeared on the scene, and as there are actually no cooking ovens in the upper or shell beds, since deposited in the cave, we can only conclude that the shells were likewise cooked outside the numerous ash-beds, tussocks, and fern-stalks, interstratified amongst the shells, suggesting that the later inhabitants lighted their fires only for warmth and light in the cave, and probably slept there.

It appeared to me important to obtain, if possible, some information from the natives whether they had any knowledge or tradition in reference to the remarkable quantity of shell heaps occurring in the inner or westerly portion of the dunes, which are found at intervals from near the mouth of the Waipara all along the coast as far as the Waitaki, and in which I could never discover any Moa bones. I therefore requested my friend, the Rev. J. W. Stack, to inquire from the oldest Maoris of Kaiapoi what they knew about them.

He informs me that these natives attribute them generally to the Waitaha, the first immigrants who preceded the Ngatimamoe, who in their turn preceded the Ngatikuri, the present inhabitants.

Seeing that these remains are assigned to the remotest period of Maori occupation by the natives themselves, the great division existing between the lower, or Moa-hunter, and the upper, or shell beds, with such a distinct line of demarcation, goes far to prove that an enormous space of time must have elapsed since the *Dinornis* became extinct.

Mr. Stack justly points out the importance of this fact in his communications to me, and thus the own traditions of the natives themselves, related in an unbiassed way, are certainly a confirmation of the views I ventured to express first in 1871, in respect to this question, and quite in opposition to the then generally accepted assumptions.

Conclusion.

Although when enumerating in the foregoing notes the results obtained during the pursuit of the excavations, I have given already my views, formed

from a consideration of the sequence of the beds of human origin, their age and peculiarities, I think it will be useful if I offer in conclusion a short *résumé* of the work performed, contemplated as a whole.

The excavations have shown that a nearly level floor of marine sands existed, resting upon the rocky bottom of the cave, these sands being 4½ feet above high-water mark at the entrance of the cave, and gradually rising to 8 feet near its termination.

There is no evidence from which it could be concluded when the big block at the entrance of the cave fell down from the roof to narrow the former so considerably, but I have no doubt that this took place before the sea had left the cave entirely, by being shut out by the boulder bank in front of the entrance, the crown of which rises 16 feet above high-water mark.

However, both the boulder bank and this rock at the entrance of the cave prevented the drift sands from entering and filling it, so that when the Moa-hunters landed with their canoes in some of the nooks of the rocky shore in the vicinity they found a capital shelter in the cave, whilst the Peninsula, then an island, and the opposite shores of the main island offered them a fine hunting ground.

It appears from the examination of the sea sands that the first visitors of the cave entered it only occasionally, and still more rarely used it as a cooking place. This might have taken place after the waves of the sea had been shut out from the cave by the formation of the boulder bank in front of it, probably assisted by a rise of the land, but it is possible that at exceptionally high tides the water still entered the cave, as some of the broken Moa bones, and of the boulders of which the cooking ovens in the south-western portion were formed, were embedded nearly twelve inches deep in the sands, unless we assume that they might have been brought into that position by the next inhabitants having walked over them, and thus having trodden them down.

The bed of ashes and dirt, which here and in a few other places underlies the agglomeratic bed, clearly proves that before the last-mentioned deposit was formed fires were lighted occasionally upon the sands.

The discovery of drift wood in the cave, often of considerable size, of several seal skeletons, and of a portion of a lower human jaw, is a proof that during the deposition of the sands it was easily accessible to the waves of the sea.

I have already observed that in the marine sands we came across blocks of rock of all sizes having fallen from the roof, and possessing a more or less rounded shape, such as is exhibited by scoria, formed in its upper and lower portions during the flow of a large lava stream.

When the waves of the sea finally retreated, a great number of these fragments fell for a considerable time from the roof, forming a nearly uniform layer

of an average thickness of 6 inches above the marine sands, and being generally thicker where the cave is highest. This fall was, without doubt, caused by the interior of the cave gradually getting drier. During the whole time of the formation of this remarkable deposit, the cave appears to have been occasionally inhabited, as evinced by the great number of bones and of small quantities of charcoal and ashes enclosed in the bed under consideration.

Above this agglomerated bed another remarkable layer had been deposited, generally 3 or 4 inches in thickness, mostly consisting of refuse matter from human occupation, and of ashes, so that I adopted the name of dirt bed for the same. It was especially in some localities, as for instance near the entrance of the cave, replete with kitchen middens of the Moa-hunters. I wish, however, to point out that the fall of the rocks from the roof did not cease during its formation or even afterwards, as all the beds upwards, even those of European origin, have small lumps of such scoria, or even larger blocks, embedded in them.

I believe, therefore, that this dirt bed was forming during a more regular occupancy of the cave by the Moa-hunters; moreover, I think that the connection of the cooking places and kitchen middens of the Moa-hunters outside the cave, amongst the dunes, with the dirt bed, has been traced satisfactorily in the foregoing pages.

But now, as it were at once, the Moa-hunters disappear from the scene; but not without affording an insight into their daily life, by leaving us some of their polished and unpolished stone implements, a few of their smaller tools, made of bone, a few personal ornaments, as well as fragments of canoes, whares, and of wooden spears, fire-sticks, and other objects too numerous to mention; but by which the fact is established that they had reached already a certain state of civilization, which in many respects seems not to have been inferior to that possessed by the Maoris when New Zealand was first visited by Europeans.

At the same time, if we consider the position of the kitchen middens on the dunes in the vicinity of the cave, and those which I discovered on the lines of inner dunes in the neighbourhood of Christchurch, even the most ardent defender of the groundless assertions that the Moas only became extinct some 80 or 100 years ago, must admit that at least in this portion of the island these gigantic birds were exterminated at a period when the physical features in this part of the Canterbury plains near the sea were different from what they are now, that large lagoon-like lakes have since been filled up, and sand dunes of considerable width have been added to those then existing. In one word, those changes during quarternary times have been of such magnitude that it is impossible to estimate, even approximately, the length of time neces-

sary for the achievement of such important alterations, worked out by the action of the sea and the rivers entering it.

And as in other portions of this island the deposits in which the kitchen middens of the Moa-hunters occur are of similar antiquity, I have no doubt that my views expressed on this subject some years ago will gain general acceptance in due time, although I know that erroneous notions to the contrary, when they have once become popular prejudices, are difficult to eradicate; especially when they are supported by one or two scientific men in New Zealand, notwithstanding that their assertions never stood the test of critical examination, and have been refuted over and over again.

That after the deposition of the dirt bed the cave remained uninhabited for a considerable space of time, is not only proved by the clear line of demarcation between that layer and the shell bed above it, in which no Moa bones were found, but also by the deposit of blown sands about a foot thick at the entrance, and gradually thinning out as it advances towards the interior of the cave. Moreover, if we consider that at least these lower shell-beds in the cave are of contemporaneous origin with those which are situated outside on the dunes to which Maori tradition assigns such a high antiquity, it is evident, judging from their situation in such a distant and well-defined position above the bed containing Moa bones, that the extinction of our gigantic birds, reasoning from this fact alone, is thrown back for a considerable space of time.

Of course it is impossible to calculate this time by even hundreds of years, but as polished stone implements have been found in New Zealand, buried in littoral beds, 15 feet below the surface in undisturbed ground, over which extensive forests are growing, containing trees of enormous size, there is no doubt that the use of polished stone implements dates far back in pre-historic times; I mean to say, to a period to which even the most obscure traditions of the aborigines do not reach.

Moreover, it has been proved by philological researches, that the Polynesian race, to which the Maoris belong, is of high antiquity, and that since their location in the Pacific Ocean, great physical changes must have taken place in this part of the earth's surface.

The similarity of the language spoken on numerous small islands situated at such considerable distances from each other, is no argument against such a hypothesis, because, under certain conditions, even without accidental or intended migrations, languages may remain nearly unchanged for a considerable space of time, I may even venture to say for thousands of years. In support of this view I wish only to refer here to the great resemblance of the Coptic with the language of the old Egyptians, as revealed to us by the translation of the hieroglyphic inscriptions on the oldest monuments of that wonderful race still standing proudly on the banks of the Nile.

If we now consider for a moment the shell-beds in the cave, we are led to the conclusion, principally judging from the absence of cooking places amongst them, and the numerous thin beds of ashes, without doubt the result of camp fires, forming distinct lines of demarcation, that the cave was only occasionally inhabited, and that for their formation alone a long period of time has also to be claimed.

The upper portion of these shell beds, immediately below the surface deposits of European origin, might be assigned to the forefathers of the Maori tribe inhabiting at present the neighbourhood, as according to their communications to the Rev. J. W. Stack, the cave had been used as shelter for their fishing parties in former times.

And thus another step towards the elucidation of the question, *when* the Moa became extinct has been made, and I have no doubt that future researches in similar localities will not only offer a confirmation of the views, as based upon the results of these excavations, but give us still more material towards a better knowledge of the life and manners of the primitive people who exterminated the gigantic birds once inhabiting these islands.

Appendix A.

Expenses incurred and money received towards the excavations in and near the Moa-bone Point Cave:—

9th November, 1872.

Subscription—	Dr. £	s.	d.
Mr. Edward Jollie	1	0	0
Mr. Samuel Bealey	1	0	0
Mr. H. R. Webb	1	0	0
Mr. J. D. Enys	1	0	0
Mr. W. P. Cowlishaw	1	0	0
Mr. William Wilson	1	0	0
Mr. George Hart	2	0	0
Mr. Charles Tripp	1	0	0
Mr. Marmaduke Dixon	0	10	0
Mr. George Packe	1	0	0
Mr. R. H. Rhodes	1	0	0
Mr. F. H. Meinetzhagen	1	0	0
Mr. F. J. Garrick	1	0	0
Philosophical Institute	5	0	0
Canterbury Museum	8	0	0
Dr. Julius Haast	6	0	4
	£32	10	4

9th November, 1872.

	Cr. £	s.	d.
To wages to R. Lournan (7 weeks at £2 2s.)	14	14	0
To wages to Alex. M'Kay (7 weeks at £2)	14	0	0
To expenses for tools, carriage, etc.	3	16	4
	£32	10	4

Christchurch, 10th November, 1872.

Julius Haast.

APPENDIX B.

List of objects found in the lower or Moa-hunter deposits of the Moa-bone Point Cave:—

	No.
a.—Remains of Mammals.	
Bones, human	1
Bones of ziphoid whales	8
Bones of sea leopard, *Stenorhynchus leptonyx*	39
Bones of fur seal, *Arctocephalus lobatus* (?) and *cinereus*	332
Bones of small fur seal, *Gypsophoca subtropicalis*	27
Bones of dog, *Canis* sp.	43
Bones of porpoise	24
b.—Remains of Birds.	
(1) Extinct.	
Bones of *Dinornis robustus* ...	13
Bones of *Palapteryx crassus* ...	18
Bones of *Euryapteryx gravis* ...	35
Bones of *Euryapteryx rheides* ...	94
Bones of *Meionornis casuarinus* ...	17
Bones of *Meionornis didiformis* ...	103
Bones of *Aptornis defossor* ...	1
Bones of *Aptornis otidiformis* ...	2
Fragments of bones of different species	51
Tracheal rings of Moas	37
Portions of eggshells of Moas (trays)	3
(2) Recent.	
Bones of *Graculus punctatus*, spotted shag	107
Bones of *Eudyptula undina*, small blue penguin	67
Bones of *Anas superciliosa*, grey duck	17
Bones of *Graculus carbo*, black shag	18
Bones of *Graculus varius*, pied shag	15
Bones of *Graculus brevirostris*, white-throated shag	12
Bones of *Ossifraga gigantea*, nelly ...	6
Bones of *Apteryx australis*, large kiwi	3
Bones of *Nestor meridionalis*, kaka...	5
Bones of *Stringops habroptilus*, kakapo	2
Bones of tui, gulls, terns, and smaller birds, not yet determined ...	148
Feathers of *Nestor meridionalis*, kaka	11
Feathers of *Ossifraga gigantea*, nelly	1
Feathers of *Graculus punctatus*, spotted shag	39
Feathers of *Circus assimilis*, harrier	1
Feathers undetermined	5
c.—Remains of Fishes.	
Bones of *Oligorus gigas*, hapuku ...	39
(Mollusks.)	
Unio aucklandicus, trays	1
Mesodesma cuneata, trays	1
Mactra discors, trays	1
Artemis subrosea, trays	1
Objects of Human Workmanship.	
a.—In Bone.	
Canine tooth of dog, bored at base ...	1
Needle made of humerus of *Ossifraga gigantea*, nelly	1
Awl made of distal end of *tibia of Ossifraga gigantea*, nelly ...	1
Proximal end of humerus of *Ossifraga gigantea*, nelly, neatly cut off ...	1
b.—In Wood.	
Apparatus for lighting fire by circular motion, made of pukatea, *Atherosperma novæ-zealandiæ* ...	2
Apparatus for lighting fire, by rubbing lengthwise, made of komaku, *Carpodetus serratus* ...	2
Portions of apparatus for lighting fire, by rubbing lengthwise, made of komaku, *Carpodetus serratus* ...	3
Portions of apparatus for lighting fire by rubbing lengthwise, made of patete, *Melicope ternata* ...	1
Portions of fork, made of manuka, *Leptospermum scoparium* ...	1
Portions of spear, made of nene, *Dracophyllum* sp.	1
Pieces of timber, pukatea, *Atherosperma novæ-zealandiæ* ...	4
Piece of timber, portion of a canoe (?) of tawai, *Fagus menziesii* ...	1
Portions of pile, totara, *Podocarpus totara*	2
Chips of totara, *Podocarpus totara* ...	3
Fork made of manuka, *Leptospermum scoparium*	1
Piece of pukatea, *Atherosperma novæ-zealandiæ*, portion of a canoe (?)	1
Pieces of tawa, *Nesodaphne tawa*, probably portions of a bird spear	2
c.—In Stone.	
Polished stone implements, adze perfect	1
Polished stone implements, fragments. One of these resembles the point of a tool called tamatau by the Maoris, formerly used by them to make fishhooks ...	17
Pieces of gritty sandstone, taraiwaka of Maoris; some with grooves from sharpening tools ...	4
Obsidian, tuhua	4
Pumice stone	2
Quartz, agate, chalcedony (cores) ...	4
Chipped flint implements, of which ten are cores; of the rest five only show any recognisable form, of which two are spearheads, three knives, the rest being mostly flakes	34

Appendix C.

List of objects found in the upper, or Maori, deposits of the Moa-bone Point Cave:—

	No.
a.—Remains of Mammals.	
Bones, human	3
Bones of whales, ziphoid	12
Bones of porpoise	9
Bones of dog	51
Bones of sea leopard, *Stenorhynchus leptonyx*	11
Bones of fur seal, *Arctocephalus cinereus*	37
Bones of little fur seal, *Gypsophoca subtropicalis*	19
Bones of rat	3
b.—Remains of Birds.	
(1) Extinct.	
Small pieces of Moa bones, mostly bleached and decomposed ...	7
(2) Recent.	
Bones of *Graculus punctatus*, spotted shag	104
Bones of *Graculus* sp.	17
Bones of *Anas superciliosa*, grey duck	8
Bones of *Circus assimilis*, harrier ...	3
Bones of *Ardea alba*, white crane ...	2
Bones of *Casarca variegata*, paradise duck	3
Bones of *Apteryx australis*, large kiwi	2
Bones of *Ossifraga gigantea*, nelly ...	1
Bones of small birds, not yet determined	37
Feathers of *Graculus punctatus*, spotted shag	62
Feathers of *Stringops hatroptilus*, kakapo	49
c.—Remains of Fishes.	
Bones of hapuku, *Oligorus gigas* ...	164
Bones of other fishes not yet determined	37
d.—Remains of Mollusks.	
Mytilus smaragdinus, mussel, numerous, tray	1
Chione stutchburyi, cockle, numerous, tray	1
Mesodesma chemnitzii, pipi, numerous, tray	1
Amphibola avellana, periwinkle, numerous, tray	1
	1
Mesodesma cuneata, numerous, tray	1
Lutraria deshayesii, kokotu, about 30 of them lying very close together upon the dirt-bed, tray ...	1
Mactra discors, a few, tray ...	1
Voluta pacifica, a few, tray ...	1
Turbo smaragdus, a few, tray ...	1
Unio aucklandicus, a few, tray ...	1
Haliotis iris, a few, tray	1

Objects in Wood, Bone, or Fibre.	No.
Pieces of a toa, a long thin spear made of tawa, *Nesodaphne tawa*, to shoot birds with. At the upper end a barbed point, called tara, was fastened, made of human or bird's bone	6
A wooden implement (fishhook) made of pukatea, *Atherosperma novæ-zealandiæ*, with a small piece of whale's tooth, called mata, standing backwards. Manga oko-oko	1
Fernroot pounders, Patu aruhe, manufactured from maire, *Santalum cunninghamii*	4
Fernroot pounder, Patu aruhe, manufactured from akeake, *Olearia* sp.	1
Fragments of Matiha tuna, fork for spearing eels, made of manuka, *Leptospermum scoparium* ...	4
Portion of a batten for a whare, kaho, made of turepo, *Hoheria populnea*, ribbon-wood	1
Portions of several Whaka kai, wooden dishes, for the preservation of fat and juice	13
Parrot-stands, Taka ore kaka, made of pukatea, *Atherosperma novæ-zealandiæ*	2
Pu-tatara, small trumpet, blown by the mouth, made of a *Struthiolaria* shell, with an opening at the point. According to Maori information, its use was confined to chiefs, the approach of whom would be announced by its sound	2
Mata, mouth of flax bag, made by twisted thin sticks, for preserving birds in their own fat, after being cooked	1
Taka kai, matting used for covering the food in the hangi, or oven, to keep it clean from the earth and ashes	2
Parenga-renga, sandals made of flax, or of ti-tree leaves (not used in the Northern Island)	3
Pieces of nets; the floater of pumice stone attached to one of them, is called poito	4
Pawa shells, in which the holes at the exterior border are filled with flax, used as a vessel for keeping oil	4
Fishhooks, Matao, for catching hapuku, made of kaikai-atua, *Rhabdothamnus solandri*	4

	No.
Fishhook, made of rata, *Metrosideros*	1
Piece of timber, of pukatea, having holes on both sides for fastening the boards of a whare ...	1
Karera, a wooden handle made of totara, to fasten a piece of greenstone, to be used as a chisel ...	1
Portion of a Patu patu, a large wooden hammer, made of manuka ...	1
Tahatiti-whaka, a squared piece of wood (totara), to fasten the sides of a canoe	1
Puru, made of manuka, pin to stop the holes of a canoe for letting the water out	2
Kauhuhua, a wooden pin, made of manuka, to fasten the battens across the canoe	2
N.B.—Some of these pieces were remarkably smooth, so that they looked as if planed. After the timber had been worked with stone adzes, it had doubtless been smoothed down with pipis, or a piece of greenstone, used like a spokeshave.	
Tokai, a thin long stick, used to keep the mouth of the fishing-net open	2
Ripipawa, a knife made of manuka, to loosen pawa shells ...	1
Matiha, fighting spear, made of manuka, pieces	6
Pieces of timber having been used for various purposes, such as firesticks, portions of canoes, whares, and utensils of daily life; portions of mats, cordage, etc. ...	53
Korapu, portion of net for catching inangas (whitebait)	1
Objects in Stone.	
Portions of broken polished stone implements	3
Portions of broken polished greenstone	1

APPENDIX D.

Objects collected in the kitchen middens of the Moa-hunters, amongst the sand dunes near the Moa-bone Point Cave:—

	No.
***a.*—Mammals.**	
Bones of fur seals, *Arctocephalus cinereus*	69
Bones of small fur seal, *Gypsophoca subtropicalis*	23
Bones of dog	36
Bones of whale (Ziphoid)	7
***b.*—Birds.**	
1.—Extinct.	
Bones of *Euryapteryx gravis* ...	33
Bones of *Euryapteryx rheides* ...	49
Bones of *Meionornis casuarinus* ...	15
Bones of *Meionornis didiformis* ...	53
Tracheal rings of different species ...	18
Pieces of egg-shells, trays ...	2
2.—Recent.	
Bones of *Graculus punctatus*, spotted shag	28
Bones of *Eudyptula pachyrhynchus*, crested penguin	17
Bones of *Eudyptula undina*, small blue penguin	13
Bones of *Anas superciliosa*, grey duck	10
Bones of *Nestor meridionalis*, kaka ...	6
Bones of *Apteryx australis*, large kiwi	3
Bones of *Casarca variegata*, paradise duck	3
Bones not yet determined (small birds)	27
Objects of Human Workmanship.	
***a.*—Of Bone.**	
Pieces of Moa-bones, partly prepared for fish-hooks	2
Ornaments made of the humerus of the albatross, probably to be suspended from the neck ...	2
***b.*—Of Stone.**	
Polished stone implements, chert ...	3
Polished stone implements, fragmentary	8
Pieces of gritty sandstone for polishing and sharpening	9
Pieces of obsidian, of which several have the form of spear-heads ...	13
Piece of pumice stone, evidently used for polishing purposes ...	1
Knives and scrapers of flint ...	7
Cores of flint	4
Flakes of flint	48
Flakes of palla	2
Chipped pieces of basalt, of which two are nicely formed spear-heads; many are evidently chipped for knives, scrapers; a few being cores	66
Total of objects collected ...	2,797

Art. III.—*Notes on an ancient Native Burial Place near the Moa-bone Point, Sumner.* By Julius Haast, Ph.D., F.R.S., Director of the Canterbury Museum.

Plates III., IV.

[*Read before the Philosophical Institute of Canterbury, 23rd December,* 1874.]

In the first days of October of last year I was informed by Mr. G. J. Quelch, of Woolston, that during the process of excavations made near the cutting by which the Sumner road leads to the Moa-bone Cave flat, the workmen had disinterred several human skeletons, together with a number of stone implements, I therefore proceeded at once there to obtain information upon the excavations already executed, and to watch further discoveries.

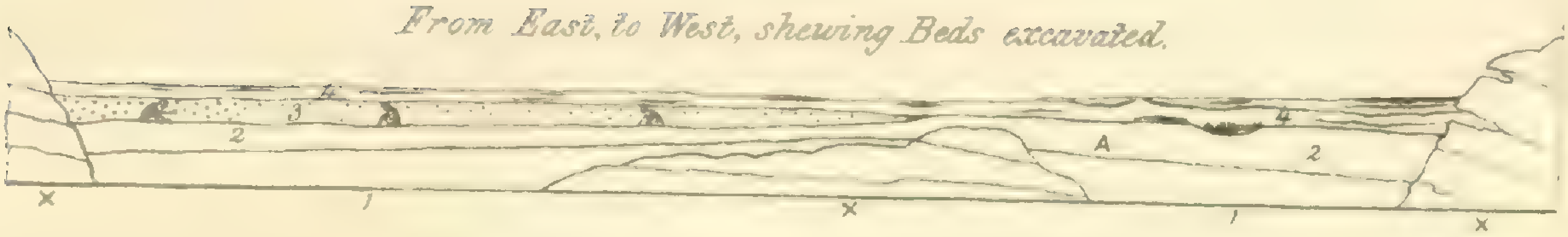
In order to widen the road, which hitherto had led at a very sharp angle to the cutting, deposits were being excavated which fill a small depression to the west of it amongst the rocky bluffs, forming here the shores of the estuary. These deposits, rising gradually to 20 feet above high-water mark, cover an area of about 100 feet broad by about 180 feet long, and were found to be separated in their lower portion into two parts by a bed of volcanic rock, well rounded by the waves of the sea, and of which the westerly portion is the smallest.

The lowest bed—No. 1 in the two sections (Pl. III.), attached to these notes—consists of true marine sands, and contained, besides some fragmentary shells, a few well-rolled seal bones. This deposit is, as far as laid open, from 4 to 7 feet thick. Upon it a sharply-defined layer reposes, No. 2 in the sections, of a totally different character, being a true slope deposit. It consists principally of loam, enclosing a few angular and subangular fragments of volcanic rocks from the adjacent hills. Some portions show traces of vegetable soil. This bed must have been formed either when the sea at this spot was so deep—no estuary existing then so far eastward—that no marine sands could be deposited at the foot of the cliffs, or during a period when Banks Peninsula had been raised to a somewhat higher level than it has at the present time so as to be here removed from the deposition of drift-sands. It has a thickness of 4 feet 8 inches on its eastern and 6 feet 10 inches on its western side, narrowing to about 2 feet in its central portion. It contained no sign of human occupancy, but a few Moa-bones were embedded in it, of which a pelvis of *Palapteryx elephantopus* was observed at letter A in the accompanying section.

The bed No. 3, which was confined to the eastern and central portions of the ground excavated, consisted generally of drift-sands about 3 feet thick, divided into several layers by darker streaks, that once may have been vegetable matter. On the eastern side, in some spots, the sands were re-

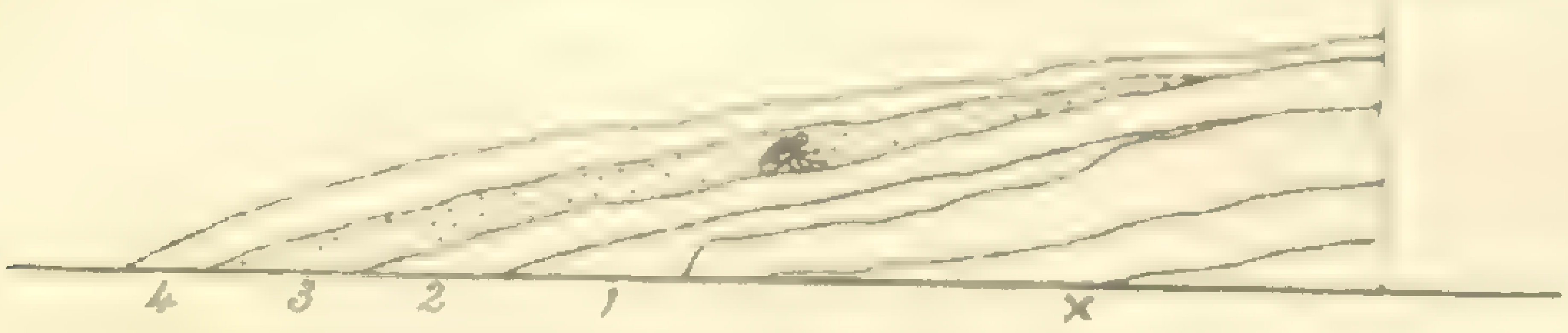
Section Nº 1.

From East, to West, shewing Beds excavated.



Section Nº 2.

From North, to South, shewing Beds excavated.



ANCIENT BURIAL PLACE, SUMNER ROAD.

REFERENCE.

Nº 4. [illegible] of shell-fish eaters.
" 3. Drift sands, with human skeletons.
" 2 Slope deposits.
" 1 Marine sands.
× Volcanic rocks.

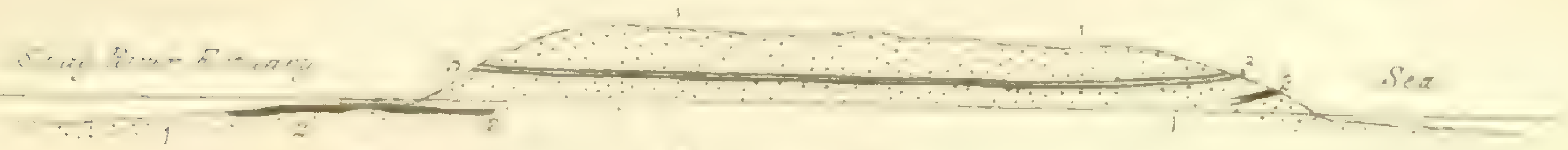
Scale 45 Feet = 1 inch.

Section Nº 1.

From North-East, to South-West, along sand-spit.

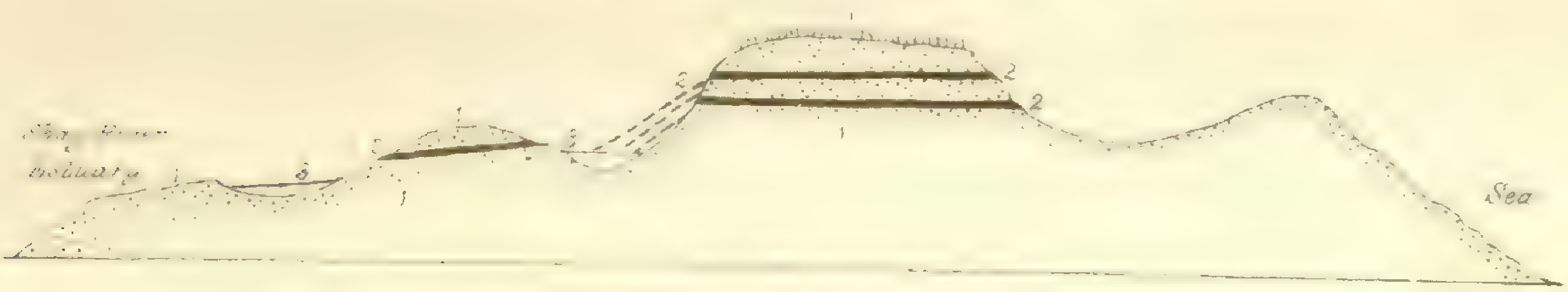
Section Nº 2.

From West to East, shewing Moa-hunter beds below high water mark.



Section Nº 3.

From West to East, [illegible] of Moa-hunter kitchen-middens.



MOA-HUNTER ENCAMPMENT, SHAG POINT OTAGO.

REFERENCE.

Nº 3. Maori kitchen-middens.
" 2. Moa-hunter kitchen-middens.
" 1. Blown sand. Marine sands. Estuary deposits.
× Tertiary rocks.

To accompany Paper by Dr. Haast.

placed by a bed of sandy clays, in the centre above the rock they exhibited the character of true drift-sands, gradually thinning out towards the west. This deposit, with one exception, contained all the human skeletons and a few Moa-bones, which were, however, quite intact. With the exception of the skeletons no sign of human occupation, such as ovens and kitchen middens, were found in it. This bed, in ascending the slopes, gradually disappears, and the uppermost bed No. 4, which on the western side lies directly upon the slope deposit, No. 2, ascends to the termination of the slope.

This uppermost layer (No. 4) consists partly of drift-sand, partly of vegetable soil and slope deposits. During its formation the shell-fish eaters were more or less frequently the inhabitants of the locality, preferring the western side, where a few small caves and a favourable aspect of the hill offered them a welcome shelter. It is on the eastern side, about 18 inches to 2 feet thick, diminishes to less than 1 foot in the centre, and gradually gains a thickness of 5 feet in the smaller western portion. The kitchen middens contained in this uppermost bed, and which sometimes form layers throughout the whole thickness, consist mostly of shells of which the *Chione stutchburyi* (cockle) is the most numerous.

Mesodesma chemnitzii, *Amphibola avellana*, and *Mytilus smaragdinus* are also well represented; bones of different species of seals and of the hapuku (*Oligorus gigas*) were also collected by me. These kitchen middens often forming continuous layers of a thickness of 2 to 3 inches, and in some instances swelling to several feet, thus resemble in every respect those of the shell-fish eating population in the cave and on the adjoining sandhills, and are doubtless their equivalent in time.

At the bottom of this bed, and reposing in a shallow grave, excavated in the slope deposit (No. 2) a human skeleton was found by the workmen, according to them of small stature. It was buried lengthwise, lying on its face, and the bones were so fragile that in removing them they crumbled to pieces. No stone implements or ornaments of any kind were obtained near it. Unfortunately I was not present when the same was disinterred, but an intelligent workman, who was present at its discovery, and in whose veracity I have all confidence, gave me this information. Moreover the shallow excavation was well defined where the bones had been lying. Of course, I have no means of judging if the body to which this skeleton belonged had been buried during or after the period when the other bodies in the central and eastern portion had been interred, although it is evident from its position that the shallow grave was excavated in the slope deposit (No. 2), and that the body was buried long before the shell-fish eaters occupied the ground, from the following observation:—A little higher up, but close to this

burial place, a large cooking oven was laid open, the stones of which had been formed, lying upon the bed No. 2, thus proving that the bed No. 4 could only have been of inconsiderable thickness when the oven was used. This oven and the space near it had been filled with some kitchen middens, consisting almost entirely of large shells of *Mesodesma cuneata* (No. 4).

I observed already that all the other skeletons were found in the bed No. 3, confined to the lower portion of the slope, which was confirmed by our undertaking, when the workmen had left, further excavations higher up, but without the least result, only the upper bed (No. 4) with the kitchen middens of the shell-fish eaters being met with, lying directly upon the slope deposit No. 2. This bed (No. 3) is therefore of particular interest to us, as it was used as a burial-place, not less than six human skeletons having been found by the workmen, either during my presence or according to the information received from them. All these skeletons had been buried in a crouching position, each with several (generally three) polished stone implements. They evidently had been placed in the ground before the uppermost bed (No. 4) had been formed, the lower surface of which being continuous and undisturbed; but at what period of the deposition of the lower bed the bodies were placed there I was unable to ascertain, as this latter was much disturbed above the graves, probably from a subsidence during the decomposition of the bodies. The skeleton found on the 2nd October, together with three polished stone implements, was presented to the Museum with two of these tools, by Mr. Thomas Sutton, one of the workmen. He informed me that the skeleton was in a crouching position, and that the three stone implements had been buried close to it. One of them is a small adze of chert (very much resembling that rock, found in the neighbourhood of Nelson), $4\frac{3}{4}$ inches long by $1\frac{1}{2}$ inches broad at the cutting edge. The second is also an adze of considerable size, made from a black siliceous schist, but which unfortunately I could not obtain; whilst the third is the lower portion of a still larger one of the same material, broken transversely at the centre. Although there is an attempt made to polish the broken surface of this tool, it is difficult to understand why it should have been buried with the body, except that it was one of the possessions of the deceased, and which he had just begun to shape into another tool.

The bones belonging to this skeleton show, by their chemical condition, that only a very small amount of animal matter can remain in them, and that it must have been buried for a long lapse of time; but as Dr. Powell will refer fully to the osteological features of this skeleton and describe the skull in detail, and Professor Bickerton will give us his examination as to the chemical condition of the bones, I shall refrain from entering any further into the subject. On the 5th October, during my presence, another skeleton was

To accompany Paper by Dr Haast.

discovered under about $2\frac{1}{2}$ feet of soil. The same belonged to a body which had also been buried in the same position as the former, together with three stone implements, of which the edges were highly polished, and which the contractor (Mr. Leathem) kindly handed over to me for the Museum. Also, these bones were in a very fragile state, the skull, like that of the former skeleton, in moving falling to pieces along the sutures. The three stone implements found with this skeleton are manufactured of the same kind of chert as that previously alluded to, and are of three well-defined forms, namely, a chisel $8\frac{3}{4}$ inches long and 1 inch broad, an adze $5\frac{1}{2}$ inches long by $1\frac{3}{4}$ inches broad, both at the cutting edge, and a peculiar tool, best described as a gouge, evidently for hollowing or planing out; it is 7 inches long, and contracts to half an inch at the sharp edge.

We possess several implements of the same pattern found at the Rakaia and several other parts of this island and of different sizes, but although the Rev. J. Stack, as well as myself, showed them to a number of Maoris, some of them aged men, they invariably answered that the use of this latter well-shaped implement was quite unknown to them. The drawings of these three implements added to these notes (Pl. IV.) will make you better acqainted than words can do with their characteristic form. During the next few days several more skeletons were excavated, but, although I generally managed to obtain the skulls, the stone implements found with them had disappeared, notwithstanding that I offered to the workmen a fair price for them. However, from the information obtained through one of the workmen, it appears that each had generally three stone implements buried with it, which were of the same form and material as those previously described, and that no greenstone implements or ornaments had been met with. Thus, on the 8th October, I obtained the skulls of two more skeletons, together with some of the bones found the day before, and which were in the same fragile state, and on the 11th the bones of another skeleton, of which the skull had been disinterred a few days previously.

From the position of the human skeletons in question we have sufficient evidence to conclude that this locality was used as a burial place before the shell-fish eaters occupied the ground, because the more or less faint lines of vegetable soil in the deposit under review are generally very much disturbed above and near the skeletons, and there is no doubt in my mind that the uppermost beds were only formed after the older occupants, probably the Moa-hunters, who were inhabitants, or at least frequent visitors of the Moa-bone Point Cave and flat close by, and who buried here their dead, had long left the ground. In the first instance, there is not the least sign of ovens with Moa-bone kitchen middens in this locality, which, offering such a fine

shelter would certainly have been used by them for a camping ground, had not other causes prevented them.* The Moa-bones found together in the sands of the same bed were doubtless portions of one bird, which accidentally had been buried in them. On the other hand, no Moa-bones of any kind were discovered in the overlying beds, only shells and bones of mammals, fishes, and smaller birds, as in the kitchen middens of the shell-fish eaters. Moreover, these successors of the Moa-hunters did not know that they were camping and feasting on an old burial ground, which, according to Maori usage, is a most sacred spot, and thus would certainly not have been inhabited by the new comers, except from ignorance of its former use.

When designating the newer occupants of the locality shell-fish eaters, in contradistinction to the older, the Moa-hunters, I wish to observe that this does not exclude the possibility, or even probability, of the latter having also used the mollusks of our seas or rivers as food, either from want of their favourite game or from any other reasons.

It would also be rash to conclude from the occurrence of polished stone implements with the skeletons under review that they must have belonged to a comparatively modern or even civilised race, because even races in a very low state of civilisation, who, to judge from their physical features and rude dialect, belong to the earliest races of mankind, possess highly-polished stone implements. I wish here only to point to the aborigines of Australia, who, without doubt, have been using such tools for numberless ages.

I will not here open up the question if the earlier inhabitants of New Zealand, may they have been Moa-hunters or shell-fish eaters, were of Melanesian or Polynesian origin, as this point can and will doubtless be settled by a careful examination of human skeletons found in ancient graves, but I wish to transcribe from the second edition of "Te Ika a Maui," by the late Rev. Richard Taylor, himself a strong supporter of the theory that the Moa became only extinct in quite recent times, a few passages showing that from what he considers reliable Maori tradition, the Hawaiki immigrants not only found when they landed on the coast of New Zealand a black (Melanesian)

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* When treating in my paper on the Moa-bone Point Cave of the agglomerate, or lowest bed lying upon the marine sands, I alluded to the remarkable absence of the same in the centre of the main cave between the four piles forming an oblong square. In order to explain this absence I ventured to offer the suggestion that a hut might have stood here before and during the time the agglomerate was formed, but I added also several reasons which made this very improbable. Since then, my friend Dr. L. Powell has offered an explanation, which from its simplicity, and moreover meeting all the requirements of the case, recommends itself to us as being the best solution of the question. Dr. Powell suggests that a whata or food store resting on the four posts had been placed in the cave, which has also here its greatest altitude. Thus also the fact of the agglomerate thinning out all around is easily explained, because the pieces of rock falling from the roof would sometimes roll a little below the whata, and thus form a somewhat irregular edge.

population, but that they also discovered kitchen middens, with Moa-bone and flint tools. If these traditions can be relied upon, it shows at any rate that the black race, before the arrival of their successors, had been hunting and probably extirpating the Moa.

So, when relating the tradition of Manaia, Taylor quotes from Sir George Grey:—"When he arrived at Rotuhu, at the mouth of the river Waitara, he stopped there, and behold, there were people, even the ancient inhabitants of the island, but Manaia and his followers slew them. They were killed, and Manaia possessed their abode, he, his sons and his people, of those men that Manaia and his followers slew, that the place might be theirs." According to Taylor, the same is recorded of Turi, who "went on shore and dwelt at Patea and slew the inhabitants thereof" (page 14).

This aboriginal race was remembered as the Maero and Mohoao, or wild men of the woods (page 15). Enumerating on page 290 the arrival of the original canoes in New Zealand, he adds a footnote to No. 12, Te Rangi ua mutu, which came to Rangatapu: "On their arrival at that place, they saw stones like English flints and Moa-bones. It is there I also discovered a large quantity of the bones of the *Dinornis.* The stones were the stone flakes used as knives, which are still there found by the side of the ancient ovens, a proof of their having belonged to a more ancient race than the Polynesian."

In any case, we have to expand our conceptions considerably as to the time past, when first the original inhabitants, may they have been black or brown, trod the soil of these beautiful islands, in a period dating back long before the so-called emigration from Hawaiki took place.

ART. IV.—*Notes on the Moa-hunter Encampment at Shag Point, Otago.* By JULIUS HAAST, Ph.D., F.R.S., Director of the Canterbury Museum.

Plate III.

[*Read before the Philosophical Institute of Canterbury, 23rd December,* 1874.]

MR. F. D. RICH, of Busby Park, whom I had the pleasure to meet in the middle of April, 1872, in Palmerston, when I was just on the point of returning from the geological survey of the Shag Point coalfield to Christchurch, informed me that on the sandspit running from southern banks of the Shag River, nearly across the mouth of that valley, and by which the stream is confined to a narrow channel close to the northern bank, extensive kitchen middens with Moa-bones were to be found, which appeared to him of considerable interest. As I had already made my arrangements for returning

immediately, I could not stay to visit the locality at that time, but I instructed the servant I had with me, before returning to Christchurch with the horses, to go there in order to collect a number of specimens.

They consisted of Moa-bones partly broken, mostly belonging to *Palapteryx* and *Euryapteryx*, and a number of chipped flint implements of the same character as those collected during my examinations of the Moa-hunter encampment near the mouth of the Rakaia, and I had no doubt that a careful survey of that locality would yield most important information upon the manner and period of extinction of our former gigantic avifauna.

I therefore at the end of November of this year, during a stay at the Waitaki, paid a visit to Shag Point, when, with the assistance of men and tools, kindly furnished by Mr. Rich, I was enabled to make such excavations that a thorough insight into the whole of the beds could be obtained. My best thanks are due to Mr. F. D. Rich, on whose property these extensive deposits of human origin are situated, for his permission to examine the same, as well as for the ready assistance afforded me.

The valley of the Shag River, which for the last four or five miles has nearly a due west to east direction, is, on the average, half a mile broad, being bounded on both sides by steep banks. The currents of the sea travelling from the south to the north have thrown across the valley at its mouth a spit consisting of marine sands in its lower, and of blown sands in its higher portion. These deposits, about 60 feet high at the commencement of the spit, where they repose against the rocks forming the southern banks of the river, gradually decrease in altitude until, near their northern termination, they are overflown by the tides, the river channel proper running here along the northern rocky banks. Inside this spit a small estuary is formed, stretching several miles up the river, and which forms here an impassable barrier to animals wishing to cross to the other side. It is evident, as the country consists on the southern banks of low rolling downs with rich soil, that they must have offered a fine feeding ground to the Moas in past ages, and at the same time a remarkably favourable hunting field to the aborigines, who, without doubt, driving them towards the apex of the deltoid space formed by the sea coast and the southern banks of the Shag River, slaughtered the huge birds wholesale on and near the spit, afterwards holding there their feasts; and, as I shall show further on, having such an enormous amount of game, they used only the main portion of each carcass for their meals.

The spit, as before observed, highest at its southern end where it joins the downs, is here about 200 yards broad, gradually narrowing to about 50 yards where the vegetation ceases, and the waves of the sea overflow it occasionally.

Both Moa-hunter and Maori ovens and kitchen middens are scattered all over the spit; the former are only visible when the sands have been blown away, or the sea has washed into the beds above them, but both being—as on the sand hills, near the Moa-bone Point Cave—in several spots mixed together in a remarkable manner. Generally, however, they are very distinct, and show clearly that a considerable period of time must have passed away before the Maoris, after the disappearance of the Moa-hunters, took again possession of that locality. This is made still more striking by the discovery of the curious fact that the Maori or shell-beds are never found at a lower level than about 2 feet above high-water mark, while the Moa-hunter beds, as far as I could ascertain, actually occur in some of the back waters of the estuary, 2 feet below high-water mark, thus showing, conclusively, that since the Moa-hunters had ceased their work of destruction, and before the shell-fish eaters had reoccupied the ground, the country had been sinking considerably. And if we admit that the former would not have dug their ovens in wet ground, and thus would have kept the bottom of their ovens at least a foot or so above high-water mark, we cannot escape admitting the inference that the country between the occupation of both populations has been sinking about 3 feet.

The annexed sections (Pl. III.) will demonstrate this more fully. Near the southern side, the sandspit is formed into several small hillocks, which, where the Moa-hunter kitchen middens are exposed, show under a capping of 3 to 4 feet of blown sands with sometimes a small layer of vegetable soil on the top, several beds of ashes, often separated by 9 to 15 inches of drift-sands. Each ash-bed is generally continuous, and 3 to 6 inches thick. The boulders, by which the huge cooking ovens of the Moa-hunters are formed, were generally situated below the ash-beds, whilst the remains of their meals are scattered most frequently all through them, as well as lying above and below them.

The succeeding shell-fish eating population generally had their camping grounds in the hollows between those hillocks, and, as is clearly discernible, frequently used the cooking stones of the Moa-hunter ovens, which had rolled down the sides from the beds higher up, being gradually destroyed by wind and weather. There are even a few localities where a talus, formed of sands and the remnants of the Moa-hunter feasts, actually covers the younger shell-beds, and of which I give an instance in section No. 3 (Pl. III.). However, when we descend to lower ground we soon observe still more distinctly the great difference between both deposits as to their position; this is principally clearly brought to view when the sand-banks abut against the estuary, and the river has cut into them. Here the shell-beds are exposed in low vertical banks, but never descending lower than 2 feet above high-water mark.

They contain mostly remains of mollusks, *Mytilus, Haliotis, Chione, Mesodesma, Lutraria*, and several others, together with fish and dog-bones; small pieces of obsidian are also embedded amongst them.

In their vicinity, and below high-water mark, a small flat stretches towards the river channel, which is in many localities literally paved with Moa-bones. The excavations which we undertook on this piece of ground proved that the lowest bed of human origin, consisting of boulders, once forming the cooking ovens, had been arranged at least 2 feet below the surface of the flat. Here and there a chipped stone implement embedded amongst the bones, and of exactly the same character, proved that the same people who feasted on and near the summit of the sand-hills, camped here on the flat, which must then have been high and dry, and, as before observed, situated about 3 feet above high-water mark, as the fires with which the Moa-hunters heated their boulders at the bottom of these ovens could not otherwise have burnt.

As the time at my disposal would not allow me to make a thorough investigation of the whole station, I selected some of the principal spots from 50 feet high downwards to the flat below high-water mark, in which, over a small area, the contents of the kitchen middens were carefully examined by me. The results were very gratifying, as not only did I thus gain a good insight into the life of the Moa-hunting population in that part of New Zealand, but I obtained also some exceedingly valuable portions of Moa skeletons, amongst others several complete skulls with upper and lower mandibles and tympanic bones, a few of which at the time had still the atlas, epistropheus, and some of the uppermost cervical vertebræ in their proper position.

It appears from the specimens collected, that the Moa-hunters of the Shag Valley must have had such abundance of game that they selected for their food only the most valued portions of the birds killed.

The principal species occurring here are *Palapteryx crassus*, *Euryapteryx rheides*, and, in a minor degree, *Euryapteryx gravis*, and *Palapteryx elephantopus*, other *Dinornis* species being only represented by a few bones of *D. robustus*, and some of the smaller kinds. Of the small *Meionornis* species, *casuarinus* and *didiformis*, only a few remnants were found. It thus appears that these latter were more confined to the open plains.

Unlike the leg bones in the other Moa-hunter encampments, which, with very few exceptions, were always broken for the extraction of the marrow, here only the tibia (long bone) had been subjected to such fractures, only a few of them being found entire. On the other hand, the greatest number of the femora and metatarsi were unbroken, the small quantity of marrow in them not having been thought of sufficient value to pay for the trouble of extraction.

I had been so accustomed to find in other localites the Moa skulls either in fragments, or at least broken in the occipital region, for obtaining the brains, that I was not a little astonished to excavate all the skulls in a perfect state, and, as the position of the vertebræ and of the tracheal rings lying along them proved, the whole portion of the upper neck had been thrown away, as not of sufficient value. It thus is evident that in most cases only the body served for food, and as some shallow broad cuts or scratches in one fragmentary pelvis and in some femora demonstrated, the same had been operated upon with rough stone knives; some of the intercostals had also been cut or sawn through in the same manner. This intactness of the Moa-skulls might also suggest to us that the Moa-hunters were in the habit of killing their prey either by snaring them, by catching them in pits, or by wounding them with spears in the body. Had they used wooden clubs, they would certainly have broken the skulls as the easiest means of securing their prey, just as we find nearly every seal skull broken from a similar reason.

Before leaving this subject, I may observe that not a single specimen—either entire or fragmentary—of the scapulo-coracoid, or wing-bone, of the Moa was obtained, while a considerable number of the intercostals and portions of sternums with them were excavated. It is a curious coincidence that thus we should have the sternal apparatus of numerous specimens and belonging to several species preserved (which according to my showing did not possess a scapulo-coracoid) without finding the slightest trace of that bone, and I may claim this striking absence from the kitchen middens as a further confirmation of my views.

Besides the different species of *Dinornithidæ* as enumerated above, the ovens contained numerous remains of several species of fur seals, of which the small *Gypsophoca subtropicalis* was most abundant; the sea-leopard (*Stenorhynchus leptonyx*) was also represented. There were also a few bones of a small whale, probably *Euphysetes*, and the ear-bone of a larger ziphioid whale, so that also in this respect these kitchen middens resembled those of the Moa-hunters in and near the Sumner Cave. Human bones were not met with in either of the deposits of human origin at Shag Point. Amongst the whole mass of bones in the older kitchen middens, I failed to find any belonging to the dog, which thus may have been either not of frequent occurrence or was not much valued, the Moa-hunters having probably such a great number of large birds at their command, that, with the exception of the oily seal flesh, they did not much care for other food.

As previously observed, a number of chipped flint implements were collected amongst the kitchen middens of the Moa-hunters, several of which, by their well-finished form, evinced considerable skill in the manufacture; they

are nearly all made from a yellowish mottled flint, which, as I have been informed, occurs some considerable distance inland. The largest specimen is 8 inches long and 3 inches broad, flat on one side, as most of them are. After the lengthwise fracture, doubtless by one blow for each surface, a number of smaller blows were given, in order to form as many indentations upon the edge, by which the tool was converted into a kind of saw. This implement, like several others of a smaller size, but of the same type, was most probably used to cut or saw through the sinews, or other tough portions of the birds or seals.

Others have the form of knives and scrapers, and others resemble spear heads. The specimens from the sands and ashes taken above high-water mark have a remarkably fresh appearance, while those lying in the deposits below high-water mark have a thick coating of patina, or, better stated, are eaten into considerably by the effects of the brackish water.

Of those remarkable primitive stone knives, broken off from a boulder by a single blow, and which are so very numerous in the Rakaia encampment, I obtained only two.

They consist of a fine-grained basaltic rock, and were evidently broken from a large boulder.

I may here mention, that in looking through the fine and interesting volume of the "United States Geological Survey of 1872," published by Dr. Hayden, I was very much struck with the following passage, page 653, in the article "On Remains of Primitive Art in the Bridger Basin of Southern Wyoming," by Professor Jos. Leidy. "I may take the opportunity of speaking of a stone implement of the Shoshone Indians, of so simple a character that had I not observed it in actual use, and had noticed it amongst the material of the buttes, I should have viewed it as an accidental spawl. It consists of a thin segment of a quartzite boulder, made by striking the stone with a smart blow. The implement is circular or oval with a sharp edge, convex on one side, and flat on the other. It is called a 'teshoa,' and is employed as a scraper in dressing buffalo skins. By accident, I learned that the implement is not only modern, as I obtained one of the same character, together with some perforated tusks of the elk, from an old Indian grave, which had been made on the upper end of a butte, and had become exposed by the gradual wearing away of the latter."

The figure of this "teshoa," a name which I wish to adopt for similar stone implements in New Zealand, is so like one of the latter that it would be impossible to distinguish them if placed side by side. At the same time, I wish to observe that the description and figures of the flint-flakes, roughly chipped, found in Indian graves, etc., are so much like those obtained in the Moa-hunter encampments that there is no doubt that the former aborigines of New Zealand

employed the same mode of manufacture and used the same form of rude stone implements as the primitive races of Europe and North America.

No polished stone implements of any kind came into my possession during the search made, except a few pieces of yellowish sandstone, of which one had a carefully polished cutting edge along one side, and another piece had a groove as if it had been used for polishing purposes. However, as these pieces were lying on the surface, there is no certainty as to their real age.

Conclusions.

It will be seen from these short notes that the observations made by me in the Province of Canterbury, as to the age and position of the kitchen middens in which the remains of the Moa are to be found, have been fully confirmed by the examination of similar beds at Shag Point, about 200 miles distant. We have always been told that the southern portion of this island must have afforded a shelter to the Moa to a recent date, but the evidence offered by the facts brought to light during these excavations strongly proves the contrary. I may be answered that the Moa may have outlived the Moa-hunters, and we are triumphantly told about Moa-bones with skin and ligaments, even recently found, but I wish to point to the facts brought forward in my paper on the same subject in Vol. IV., "Transactions, New Zealand Institute," in which I have, and I trust conclusively, shown that there are exceptional causes to which this remarkable preservation is due. When the bones of *Megalonyx jeffersoni* were found in the Mississippi Valley, which had the cartilages still adhering to them (see "*Lethæa geognostica Bronn*," Vol. III., page 1,010), nobody argued from this unusual occurrence that this gigantic sloth had only been extinct for a short time; and, in fact, the very position of the different specimens of the *Dinornithidæ* found in Otago (the Tiger-hill skeleton, feathers in another locality, and the neck, etc., in the Earnscleugh Cave), proves that they all owed their—sometimes only partial—preservation to peculiarly favourable circumstances, easily to be accounted for.*

The change of level between land and sea which took place after the kitchen middens of the Moa-hunter had been formed, and before the shell-fish eating population had visited the same locality, is a further strong evidence that a portion of the Southern Island underwent some physical changes after the time when the Moa became extinct, at least in that part of the country. I have, of

* That organic bodies can be preserved for a considerable time is sufficiently proved by the human bodies excavated in the last few years from the peat deposits of Northern Germany. They are said to be "mummies in a marvellously preserved condition," and of which skin, hair, and tendons have been best preserved. Bronze ornaments and seven glass beads were found with one, Roman coins belonging to the time of Septimus Severus (194 A.D.) and iron weapons with two others. See "Moorleichenfunde in Schleswig-Holstein." Von Heinrich Handelmann and Ad. Pansch (Kiel; Schwers), and of which an interesting notice appears in the "Academy," 19th September. 1874.

course, no means of judging of the age of the kitchen middens of the shell-fish eaters, but it is evident that they are not of recent origin, if we take their position and contents into account. In fact, I believe them to be the equivalents of similar beds near the Sumner Cave, and which the natives themselves assign to the Waitaha, the remotest Maori occupation. On geological evidence alone the kitchen middens of the Moa-hunting population at Shag Point must therefore be pronounced to be of considerable antiquity.

Art. V.—*On the Identity of the Moa-hunters with the present Maori Race.* By Alexander McKay, of the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 8th August*, 1874.]

During the spring of 1872, under the direction of Dr. Haast, of Christchurch, I excavated what is known as Moa-bone Cave, which is situated about seven miles from Christchurch, on the Christchurch and Sumner Road; the object of the excavation being to procure further information relative to the association of Moa-bones with the remains of the former human inhabitants of the cave. On the completion of the work I supplied Dr. Haast with a report embodying the main facts collected during the progress of the excavation, together with ample collections of the various relics found. My present paper is but an amplification of the report mentioned, with the addition of my own views respecting the matter at issue, viz.:—Whether the Moa-hunters were possessed of tools other than those of the rudest description; and whether this constituted a distinction between them and the Maori inhabitants of later times?

With these objects in view work was commenced on 3rd October, and was continued for the following seven weeks, during which period the entire cave and a considerable area outside was turned over.

The cave is situated in a low spur of the volcanic range just opposite the junction of the Avon and Heathcote rivers, the mouth of the cave looking north-west, and facing the estuary of the two rivers. The cave itself results from the excavation by the sea of an old soil and other loose material between the two compact streams of lava rock, and it consists of three separate chambers in a nearly straight line from the entrance.

The outer cave is by far the largest. It measures 100 feet in length, 74 feet at its greatest width, and varies in height from 12 to 25 feet. The walls are for the most part nearly vertical, the roof jagged and uneven, as its varying

height will indicate. The entrance, 40 feet in width, is obstructed by large masses of the upper bed having fallen across the entrance.

The middle cave is but a lower recess at the further end of the outer cave, and measures 16 feet in length, 14 feet in width, and is not more than 10 feet high.

The inner, or third cave, is reached by a narrow passage at the further end of the middle cave, and is but a narrow opening, so low as to be entered with some difficulty. All three caves contained Moa-bones, flint implements, and much charcoal, though the accumulations of importance were nearly all contained in the outer cave. Exact measurement showed the sandy floor of the cave to be but a few feet above the level of high-water mark, though the accumulation of drift sand outside reached an elevation considerably higher.

The barrier of fallen rocks in the entrance of the cave doubtless prevented the ingress of drift sand to the outer chamber of the cave, and they may therefore have been in their present position before the final recession of the sea. But the perfectly smooth and level floor, even close up to the rocks, indicates that the water flowed in and out in one unbroken sheet, and that therefore the rocks in question must have fallen at or subsequently to the elevation of the land. Examinations outside the cave showed that occupation had originally taken place on a very uneven surface, many of the original sand hills yet forming the highest part of the present ones; the depressions being but filled-up hollows of yet greater depth, beneath the superficial drift of which often occurs a bed containing works of art and bones of man, dog, Moa, etc., resting on the undisturbed sand beneath.

Much drift wood lay scattered over the sandy floor of the cave, and above that was a bed of breccia, the accumulated *débris* from the roof of the cave, which was somewhat unequal in its distribution, reaching its greatest thickness near the middle of the cave, where in places it was from 3 to 4 feet, and where the roof was very uneven consisted of larger material than elsewhere. This bed contained great quantities of bird bones of small size, and many seal bones, some of rare or unknown species, together with a few flints and a piece of obsidian, evidently here through human agency. But the chief interest attaching to this bed is the occurrence of a human jaw and one of the principal bones of the heel, in a spot where it had evidently not been disturbed. The jaw was found buried 6 inches beneath the surface of the sand, and immediately below the remains of a seal that had evidently been stranded there. In the conglomerate itself the further finding of several charred seal bones, where the bed was about 15 inches thick, and the fact that the drift wood underlying it was much burned on its upper surface, is evidence that the cave was occupied thus early. Still, while not doubting that the

upper part of this conglomerate belongs to the earliest period of occupation, I would hesitate to say that the middle and lower parts do, as the vicinity of an oven, dug into the underlying sands, may account for the charred wood and bones. But the human bones were found in a purely undisturbed locality.

The conglomerate was overlaid by what, in order to distinguish it, I have called the dirt-bed, consisting of charcoal, chips of wood, fragments of nets and matting, tools of wood and stone, quantities of grass and fern, altogether forming a matted compound well deserving the appellation. Many bones of various birds, Moa included, were found in this bed ; and, as we neared the mouth of the cave in the progress of the excavations, polished stone tools of high finish and keen edge were found in such positions as would lead to the inference that they belong to the bed in question, and are therefore contemporaneous with the Moa, whose bones are found in the same bed. In the north-east and further end of the cave, surrounding and underlying an immense rock fallen from the roof and resting on the drift-wood, were found many Moa-bones, and various Maori appliances for obtaining fire, and near an oven dug through the conglomerate quantities of Moa egg-shells were found.

Near the middle of the cave the conglomerate had evidently been cleared away and a house erected, of which three posts burned to the level of the dirt-bed were in place when the excavation was made. In front of where the door of this house should have been, in a small hole dug through the dirt-bed and underlying conglomerate, lying directly on the sands, I found a well polished stone chisel, and near the same place several broken adzes in the dirt-bed in the close vicinity of Moa-bones. Six or eight feet from the western wall, and about 10 feet from the line of fallen rocks in front of the cave was found a fragment of a highly polished adze, and between that and the wall two pieces of sandstone much grooved as though by the sharpening of a narrow tool.

Here were heavy fire-beds with many Moa-bones of the largest size, and several stones like oven-stones, but not enough wherewith to line an oven of size sufficient to cook a Moa in. This leads me to suppose that the Moa-hunters cooked their repasts outside, and only occasionally had meals inside. Otherwise how shall we account for the comparative scarcity of bones inside and their comparative abundance outside the cave under circumstances much less favourable for their preservation.

A notable feature of this dirt-bed was the almost entire absence of the remains of shell-fish which are so plentiful in the overlying beds, a peculiarity so striking as to be evident at a glance in the sectional trenches cut across the principal chamber of the cave.

A bed of loose shells, mostly freed by means of fire from extraneous consumable matter, having in places beds of earthy lime, the result of their

decomposition, of a thickness not less than 12 or 14 inches in places. This was overlaid by a bed of grass and fern-leaves in which European and Maori materials were freely mixed. The thickness of the purely shell-bed was in places scarcely short of 5 feet, the other overlying beds varying from a few inches to 2 feet.

The inner caves offered no points of interest, save that fire-heaps and Moa-bones were found in them.

Excavations outside the cave gave much the same results as the excavations inside, viz., that polished implements occurred associated with Moa and dog-bones in beds having comparatively few or no shells, and I cannot entertain a doubt but that the Moa-hunters were, as well as the more modern Maoris, possessed of instruments of high polish, both in wood and stone. The Moa-hunters also hunted the seal, as their bones are freely mixed with those of the Moa, and fragments of nets would seem to show that the fisherman's art was not unknown to them.

In the cave Moa-bones did occasionally occur in the upper shell deposits, but they were of rare occurrence, and were undoubtedly foreign to the bed in which they occurred. I have reason to believe that the clear and distinct line of parting between the beds containing Moa-bones and the overlying shell-beds (the materials of neither transgressing their proper boundary) marks a very long blank in the history of the cave as a human habitation, and that only the desertion of the cave during Moa-hunting times, in order to follow the game to its furthest fastnesses after its extinction on the hills of the neighbourhood, can account for the fact in a satisfactory manner. Such a radical change of food as is indicated by the very different material of the deposits could not have been brought about in a short time ; and whether or not it be agreed that its more recent occupants were the same race, the fact must remain the same, that it was uninhabited during the period of the final extinction of the Moa in a large district of the surrounding neighbourhood.

With regard to the vexed question whether the Moa-hunters were Maoris or another race, I cannot think that any light has been thrown upon the mystery, for a mystery it yet remains in spite of several very ingenious endeavours to enlighten us upon the matter. Hitherto every attempt in this direction has failed, more or less. But it is doubtless easier to propound a theory than to defend it against the attacks of an opponent. It is a subject of surpassing interest, and one that may well engage the attention paid to it by several of our chief scientific observers, who, though by no means arriving at the same conclusions, yet ably and stoutly defend each his own theory on the subject.

With all deference to the maturer judgment of those whose studies in time past may have been directed to the subject, I cannot regard as of high value

any investigations carried on in native encampments of the Moa-hunting period; at least not until it is clearly established how they are related to each other in time, and as yet the first step has to be taken in the fixing a chronological succession to these accumulations. No doubt such an attempt will have its difficulties, and not the least will be the want of a starting point at either end of the scale. The want of such a positive stand-point whereby we might compare the relative age of encampments that must vary very much in point of time must necessarily constitute the first difficulty to be got rid of. As for example, who without such a test shall judge whether the encampment at the mouth of the Rakaia is older than that at Moa-bone Point, Sumner, or in what relation to these former stands the encampment at Shag Point?

Briefly summed up, the evidence is contradictory; that is if we admit the evidence by which we support the claims of the different encampments to be of equal value. Thus we should say that the Sumner encampment is younger than that at the Rakaia, because in the latter no traces of polished implements have been found directly in contact with Moa remains, or in the accumulations proper to the period when the Moa served as food for the inhabitants. It is very generally admitted that in such an encampment the absence of polished tools and other works of art of high finish indicates surely a time prior to the attainment of the art of so polishing, and that accumulations containing polished tools must of necessity be the younger. In a paper read to the Wellington Philosophical Society, Dr. Hector has shown that in association with Moa remains such polished implements would necessarily be rare, and that by their absence it need not necessarily be inferred that they were not held in possession. Thus, on these grounds, I cannot hold that the Rakaia encampment proves by that test to be either older or younger than the Sumner. But for the presence of Moa-bones it might have been a Maori encampment of yesterday. The Sumner encampment does certainly contain polished tools in connection with Moa-bones, and were such a test to be depended on, it would go to prove that it is the younger of the two. But if, as is reasonable to suppose, a stone hatchet, or a polished *mere*, was an implement less serviceable in the dismemberment of a fallen Moa than a sharp flake of flint with an edge far superior for the purpose in view, then we can readily understand why polished implements should be so scarce.

But to apply another test of the relative age of these beds. The excavations at the Rakaia have not hitherto disclosed the remains of any of the larger species of the Moa, and it may be fairly argued that the more gigantic forms would be the first to disappear, whether in the ordinary process of extinction or by the hands of man. In the Sumner encampment are found the remains of the species *robustus*, which seems to have been extinct when

the Rakaia encampment was occupied. This much we may presume, since the plains would certainly form the more suitable feeding ground for such a large bird. Their remains at Sumner would, I think, indicate a time when they were comparatively plentiful, and consequently a time prior to their supposed extinction at the Rakaia; while the absence of polished tools at the Rakaia in the face of their occurrence with Moa remains at Sumner, does not, I think, prove more than that the occupants of the Rakaia encampment were more careful of their goods than their Sumner brethren.

Grounding my premises on evidence already produced, it may be contended that a considerable time elapsed from the time that the last Moa was eaten on the site of the Sumner encampment, till were begun the accumulations of mollusk remains aggregated in after times. This interval may have been sufficient for the accumulation in other localities of considerable quantities of material containing the remains of the Moa, which may even have been contemporaneous with part of the after accumulations of shells in the Sumner Cave. This might possibly be looked upon as an admission that the Moa might have reached a very recent, even an historical, period in the history of New Zealand, but all that is meant is, that it reached a time posterior to the accumulation of some of the shell mounds. How long individual instances may have outlived the general extinction it is not even pretended to say.

Possibly elsewhere encampments may be found which were occupied continuously, and where the evidence will be found to point to the gradual progression of the Moa-hunter into the fish-eater. The question viewed in this light at once points to the identity of the Moa-hunters and the present inhabitants of these islands.

We have thus seen that the extinction may have been a gradual process, and that many shell accumulations may be contemporaneous with existing mounds containing Moa remains. But it is yet to be proved that these latter accumulations are the works of the present Maori race. For it follows of necessity that these post-Moa-hunter accumulations and those of the modern historical Maori would be very much alike, as were their necessities, and it is by no means clearly proved that the Moa-hunters were Maoris, or *vice-versâ*. Nor will it, in my opinion, prove ought else than that after the extinction of the Moa its destroyers were compelled to live on shell-fish, and in the main subsist by the products of the sea. It would also appear that when the shell mounds of the Sumner cave were accumulated, maize and European products introduced by Captain Cook were unknown, as no traces of such were found, while materials apparently as liable to destruction were found in abundance.

But, throwing aside this evidence, and accepting as fact that the Moa-hunters cannot be proved identical with the progenitors of the present

Maoris, let us see how far the opposite will prove the Maoris to have been Moa-hunters. Maori traditions must be in some measure for a few generations back, and as far as we dare place confidence in any compilation of these traditions they in nowise prove the Moa as contemporaneous with the subjects of these traditions. Maori traditions, collected after this subject has been so freely discussed, must naturally be accepted with great reservation.

Now if, as commonly stated, the present inhabitants immigrated hither, say 350 years ago, and if, after their arrival here, the Moa was exterminated by them, I cannot but think that reliable accounts would have reached present times. And if individual specimens of the Moa lived till times as recent as 50 or even 100 years ago, surely a people who could preserve exact tradition of matters to them much more trivial, could hardly have failed to have given them a prominent place in their traditions. And thus we are led to suppose that a people prior to the advent of the present stock were the exterminators of the Moa, always accepting as incontrovertible that the immigration alluded to did not take place 1,000 years earlier than stated in the said traditions on the subject.

But, in the mean time, accepting the 350 years, and treating 1,350 as a wild notion which the science of the subject has never yet dreamt of, let us see if the 350 years will be sufficient for the accomplishment of all that of necessity must be performed by these immigrants and their descendants.

The generally received accounts state that the immigrants were far from being numerous. Also that quarrels—probably wars—ensued shortly after their arrival here, which would certainly tend in no inconsiderable degree to retard the natural increase of the population, while little encouragement is held out that population is materially assisted by further immigrations from Hawaiki.

Further tradition states that at a very early period in their history were built those terraced hill-forts so abundant in some parts of the North Island; and all agree that a considerable population would be required for their construction; while it is further added that they are the works not of whole sections of the community, but were executed by the various *hapus* of the different tribes.

And if, as we have seen, the original inhabitants were few, and their increase naturally greatly retarded by war, yet they must have been early in a position to undertake the execution of the works spoken of. And if they are the work of district tribal sections, I cannot see that, considering the circumstances, the 350 years will be nearly sufficient for the natural increase of the few original immigrants in sufficient numbers for the execution of even a portion of such works, if their antiquity be as stated.

On all hands it is admitted that 200 years ago a numerous population existed in New Zealand, which, since that time, has been gradually on the decline, chiefly on account of the exterminating wars carried on amongst the natives themselves. And, if the population culminated more than 200 years ago, will 150 years be sufficient for the increase of a few immigrants in sufficient numbers so as to render a large country like New Zealand comparatively populous?

In all their traditions, treating of nearly four centuries of time, have any accounts of the Moa been handed down to us? The inevitable conclusion is, that the Moa was either exterminated long before by another race, or that the present inhabitants arrived here not 350 years ago, but 1,350, and that one of their first works was the extermination of the Moa. Such is my opinion on the subject.

Art. VI.—*On the Hot Winds of Canterbury.* By Alexander McKay, of the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 12th September,* 1874.]

The north-west winds, which throughout most of the summer months prevail in the Province of Canterbury, are generally regarded as dry and hot winds, and an unmitigated curse to the country. Their ravages throughout the agricultural districts and the discomfort they occasion are sufficiently well known; their character, as there developed, seems to have been applied to the whole province as a rule. It has also been given in explanation of the very different character of these winds on the two opposite sides of the South Island that in their passage across the Southern Alps their moisture is condensed by the extreme cold of these regions, they descending to the lower regions as dry and hot winds. I shall be able to show that this process is but very imperfectly performed by the higher and snow-clad ranges.

As dry and hot winds they are chiefly prevalent on the plains of Canterbury, but only exclusively so at a distance from the ranges that skirt the western borders of the plains. I was resident for twelve months at the Ashley Gorge, Canterbury, during which time north-westers were unusually prevalent, and almost without exception. After blowing for a few hours as a dry wind heavy rain set in without any change in the direction of the wind, though immediately the rain commenced the wind gradually fell away. These rains, however, seldom prevailed to a greater distance than four or five miles in the direction of the plains. What is true of the Ashley Gorge will equally apply

to Oxford and the gorge of the Waimakariri. In a lesser degree it may be to the Malvern Hills and the gorge of the Rakaia. I am also well aware that these rains invariably follow north-westers in the valleys of the Ashburton and the Rangitata, and usually extend for a few miles beyond the ranges in the direction of the plains.

These remarks apply with equal force to the Mackenzie country as far as the Waitaki River, and the boundary of Canterbury with Otago in the neighbourhood of Lake Ohau.

A glance at the map will show that the region thus favoured is by no means an insignificant portion of the Province of Canterbury, throughout the whole of which it cannot be said but that these north-west winds, on account of their warmth and accompanying rains, are an undoubted benefit where otherwise late and cold springs would prevail, greatly interfering with the profits of the sheep farmer. I could not say whether or not the strength of these winds is in any way modified by the height of the mountains, but this, I think, may be safely asserted, that in the Mackenzie country and the neighbourhood of Mount Cook they blow with equal, if not greater, violence than in any other locality that has come under my observation. In this district I had occasion to watch the behaviour of the north-wester very carefully, and a few facts connected therewith may not be out of place.

Lake Ohau forms one of the line of lakes which skirt the eastern side of the main range, and fills the lower part of the valley which lies between Ben Ahau and the mountains to the westward, and is notable amongst all its sister lakes on account of the strong winds that blow here from the north-west. The river which feeds this lake, four miles above the head of the lake, divides into two branches, severally known as the Hopkins and Dobson rivers. Along the valley of the first of these rivers the north-west winds chiefly blow, and are comparatively rare in the Dobson River Valley, it only being when storms of unusual violence occur that the north-wester blows here at all. North-westers occur here at all seasons, but are chiefly prevalent from October till March, the most violent storms taking place in the month of February. North-westers are usually succeeded by rain from the north-west. If rain does not follow after five or six hours the north-wester is met and driven back by a southerly wind. A north-wester may pass down the north-east side of the lake while a southerly wind prevails on the south-west side.

Sometimes when the north-west wind is stronger than usual, and is met by the south wind, neither gives way, and may thus remain stationary within a quarter of a mile for five or six hours.

Usually a north-wester commences about 10 o'clock in the morning, and if it does not rain by 3 p.m., is driven back about 5 p.m. by the south wind.

Storms of the first order will continue for a week, bringing rain at intervals. Those of the second class are usually driven back by the south wind.

Fitful and hot winds invariably die away and are succeeded by rain.

A north-wester may prevail on the lake and the lower part of the gorges, while an equally strong wind may blow from the south in the upper part of the gorge. This is remarkable, as high continuous ranges hem these gorges in on all sides, save that already occupied by the north-west current. Sometimes a north-wester may be seen to drift the snow off the top of Mount Cook in a south-east direction. But on such occasions it has either blown since the previous evening, or commenced before sunrise. North-westers which begin after sunrise are usually indicated by a few light coloured clouds in the neighbourhood of Mount Cook and the higher peaks of the main range. In this region at all times thunder prevails, but chiefly in the winter with north-west wind and rain.

I might have added yet further to these remarks, but I think that I have said sufficient to show "Its an ill-wind that blaws naebody guid," and that the north-wester is not quite such a bad friend as we took him to be.

Art. VII.—*Observations regarding the Hot Winds of Canterbury and Hawke Bay.* By T. H. Cockburn-Hood, F.G.S.

[*Read before the Wellington Philosophical Society, 25th July,* 1874.]

During the conversation which took place at the last meeting, after the President's very suggestive address, doubts were expressed as to the hot winds of Australia having any influence upon the climate of New Zealand. The subject is an interesting one, and I take the opportunity of noticing some facts connected with it, which may be worth the consideration of those who have given attention to the meteorology of this portion of the southern hemisphere.

My first visit to New Zealand was in the year 1858. A fierce hot wind which had blown for some days carried us out of Sydney harbour, and filled our sails for a few hours after leaving the coast, when it suddenly dropped, and we encountered one of those severe southerly gales, locally called "brickfielders," which was, however, as they are generally, of short duration. As the dense black storm-drift rolled up along the sea, the red-edged clouds borne on the north-wester could be observed rapidly passing on above it. During the remainder of the voyage we had strong southerly and south-easterly breezes, with cloudy weather and heavy rain as we entered Cook Strait.

Never having heard of hot winds in New Zealand I was consequently the more surprised to find, shortly after my arrival at Christchurch, a strong north-west gale come on to blow, which continued for some days, and seemed to possess a large share of the disagreeable characteristics of the sirocco of Malta and Southern Europe, or the desert winds of Australia, whilst the sky presented the same hard features, the same almost stationary ominous clouds in the upper atmosphere, so familiar to travellers in these countries.

I have used the term "desert winds" to indicate that those are alluded to which blow over the great levels of the continent, although the term is scarcely applicable, as the extent of country actually deserving the appellation of desert is much less than generally supposed.

On inquiry I found that these winds had been very frequent during the previous months, as they had also been in Australia, and came to the conclusion, as stated by me in a paper after my return, "That the hot winds which blow over the southern regions of Australia rise above the lower currents, gathering additional moisture as they pass over the intervening sea, and impinging upon the mountain wall of the cordillera of New Zealand, rapidly discharge their burthen upon its western slopes, and rush dry and blighting over the Canterbury Plains."

These winds are then really dry when they leave the Australian coast, as may be proved by exposing a tumbler of ice to the current, when the moisture contained even in their lower strata is quickly condensed. They are not so. Peculiar electrical conditions may produce the enormous evaporating power they possess (so injurious to vegetation and disagreeable to the sensations), which those only can well believe who have watched daily with anxious eyes the deep lagoons upon which their safety depends disappearing, not by inches but by feet.

All the observations and inquiries which I have had an opportunity of making since tend to strengthen my conviction. The theory however does not find favour with several persons whose conclusions are entitled to much weight, as those are which have been arrived at by so diligent and accomplished an observer as Mr. Travers. How he and others who entertain a different opinion account for the western coasts of these islands being covered with dense forests, and receiving a rainfall of more than four times the amount annually discharged upon the treeless plains on the eastern side of the main range, I am not aware. Certainly an analogous, indeed almost an exactly similar condition of things obtains in Patagonia, where glaciers descend also through the forests of beech and fuchsia to the sea, as they do nearly in the south island, with the fronds of tree ferns waving over the ice. But these Patagonian forests

are all the year round under the influence of the rain-bearing westerly winds. On the coasts of New Zealand there cannot be said to be any prevailing one; and if it owes nothing to those passing over the adjacent continent of Australia, some other cause must be shown for the westerly ones which reach its shores being so much moister than the equally strong easterly gales.

In summer, during the quiet beautiful mornings, under the powerful rays of the sun, the radiated heat over the dry plains of Canterbury raises the temperature to an extent scarcely to be expected in that latitude, and the lower strata of air become quickly rarified; about mid-day red clouds of dust are seen filling the gorges of the great rivers, by which they debouch from the mountains, and the current rushes down over the plains to fill the vacuum, acquiring by its rapid motion somewhat the character of a hot wind. But these are merely local blasts, of short duration, and as evening approaches all again is calm and still, and no rain has fallen on the mountains.

It is very different, however, on the occasions when the north-westers blow intermittently for several days and nights over the Canterbury levels, and, in a lesser degree, over those of Hawke Bay, withering the vegetation, crisping the leaves of succulent plants, so that they may be rubbed up like dry tinder, and exercising a most depressing effect upon the energies of animals as well as those of human beings.

Then torrents of rain are being discharged upon the forest-clad mountains of Westland, and floods in the rivers running to the East Coast announce the melting of the snows in the higher regions. When telegraphic communication is established between the two countries we shall be able to ascertain the rate at which these winds travel over the intervening sea.

Meantime I have ascertained for certain that when hot winds have prevailed to any extent in the southern parts of the Australian continent, their influence has generally been extended to the shores of New Zealand, and that it is not merely upon the occasion of such a hurricane as swept the dust and ashes of the conflagrations which occurred on that terrific day known as "Black Thursday" in Victoria across the ocean, and darkened the air in Otago, that the denizens of these islands are affected by the same influences as the dwellers on the banks of the Murray and Darling rivers.

What are properly called hot winds do not generally blow up to the tropic in either hemisphere. On the eastern coasts of Australia they do not extend their influence much beyond the 28th parallel of latitude. In Queensland I can, from many years' personal experience, state that they are almost unknown, even on its southern borders at Darling Downs.

If we take the next eight or ten degrees as the zone of their greatest strength, and extend W.N.W. parallels (which is nearly the course in which

they blow) we shall find that New Zealand from Mokau, south, will fall within their influence. So that the objection raised by Mr. Travers that so small a portion of Australia is beyond the 34th parallel is not of consequence as affecting the question.

The eminent astronomer, Sir Thomas Brisbane, once Governor of Australia, warned me when I first went to that colony, to be on my guard against floods as well as the dreaded droughts, as periodical cycles of wet seasons were certain to occur, in consequence of the southerly extension of the south-east trades. During the last few years unusually heavy rains have fallen all over the territory of New South Wales, as well as in the northern tropical regions of Queensland, extending back to the great levels beyond the Darling. When a river, flowing through a gorge as the Burdekin, an eastern water, does, a mile wide, is raised 100 feet in perpendicular height, it will not be a matter of surprise that these usually arid regions have been temporarily covered with water, as they were when Mr. Oxley, the explorer, first penetrated to what he supposed to be an inland sea.

Now it is a very interesting fact that during late years the withering effects of the north-westerly winds have at times quite taken people by surprise upon the western seaboard of the North Island. Until the last five or six years winds from that quarter were always sure to bring rain in summer to the expectant farmers at Taranaki, whereas they have now come to be dreaded, as causing their crops and fruit to be blighted. During last summer a W.N.W. wind blew for two days, possessing quite the depressing effect of the sirocco. The sky was cloudless, but round the very summit of the cone of Mount Egmont remained a halo of white cloud, perfectly unchanging in shape and extent; so hot was the blast, at all events so great its absorbing powers, even at that elevation, that no fleecy streams were borne away with it from the mountain top.

I inquired as to the weather on the opposite coast at the time, and found that rains had fallen on the mountains, flooding the rivers which run to Hawke Bay, whilst heated winds were parching the plains around Napier. Mount Egmont at this time was nearly without snow, a little only being visible in the crater, so it will be readily understood that the sharp mountain peak was not sufficient to condense the vapour to such an extent as to produce rain at Taranaki; for it was evident that this particular current, which seemed so devoid of moisture to one's feelings, and no doubt left the Australian coast really a dry wind, having deposited its burthen on the usually thirsty plains of that country, had gathered a considerable amount in its passage over the intervening sea, which for some days previous had been perfectly calm, so the partially loaded westerly wind descended and struck upon the land at the sea level.

It was not so during the summer all over New Zealand. The dry blasts, which left the Australian coast, ascended into a higher zone than usual, and brought no rain to the western coast of the South Island, passing on over its mountains until, saturated at last, they returned possibly as a south-east wind, bringing rain to the eastern coasts in unwonted abundance.

However this may be, the facts mentioned seem to bear very pertinently upon the theory suggested by Dr. Hector, that to the elevation of the interior of Australia is to be attributed the shrinking of the New Zealand glaciers.

When the vast levels of that continent were submerged, the returning equatorial winds came loaded with a far greater weight of "that vast stream of molecules of water, each enveloped in its own shroud of electric vapour," upon the mountain chain of the great land, the back bone of which and little more remains.

The soundings between New Zealand and the Chathams to the east, Norfolk Island and the Kermadec group to the north, are not very profound. So when the cordillera stood at an average higher altitude of from 4,000 to 5,000 feet, as Mr. Travers says, the whole of that great area would be dry land, and we have depicted to our imagination a grand country, intersected by majestic rivers, in which such giant forms of life as the *Dinornis* can more easily be conceived to have originated, than in the limited islands, where the last of the race remained after all the vast changes of scene and climate during which they survived until the present century.

With such a mighty engine as the equatorial current depositing its load of moisture on the névés of these mountains there is no necessity for seeking for other causes, evidences of which are not to be seen; and to suppose it necessary to assume that the same circumstances obtained in remote epochs in the Australasian regions, as in the northern hemisphere; nor to conclude that New Zealand at that era presented in any degree the desolate appearance Dr. Haast supposes.

The development of the glaciers under the cosmical influences proposed would be quite sufficient to account for all the phenomena now so interesting to geologists in the terraces of the river valleys and the lake basins of the alpine regions, and the materials were then prepared afterwards to be spread out by the rivers as the land gradually subsided on the Canterbury Plains—a process still going on—the formation of which has been so graphically described by Dr. Haast. It is impossible for any one who has studied his last report to speculate upon the possibility of these vast accumulations being of marine origin, even although he may not have traversed the paved plains of the Rangitata and Rakaia, and had an opportunity of observing the form of the stones and gravel, nor have searched in vain for any fossil of

marine origin in the sections at the gorges of the rivers, unless below where some remnant of the abraded and buried tertiaries has remained and is exposed; nor seen evidence of the gradual subsidence in the remains of the successive forests which have flourished, and been overwhelmed in their turn by the streams of stones and other fluviatile deposits, which general subsidence, if it is now arrested, has been so but at a comparatively recent date. Even totara, durable as it is, will not remain for geological eras unchanged. Submerged forests of this timber in good preservation are to be seen in the North Island, where the land is broadest, near Wairoa, on the East Coast, and immediately opposite between Urenui and the Waitara rivers.

Art. VIII.—*Notes upon the probable Changes that have taken place in the Physical Geography of New Zealand since the Arrival of the Maori.*

By T. H. Cockburn-Hood, F.G.S.

[*Read before the Wellington Philosophical Society, 29th August,* 1874.]

In a paper upon the subject of the recent existence of the Moa I some years ago ventured to state my opinion that if the theory of its extinction before the coming of the Maori be accepted, a very great age must be accorded to the singularly well-preserved remains of those great birds, as from many of the traditions of this people we are led to the conclusion that the date of the first landing of their forefathers on these shores is much more remote than generally supposed.

It may have been that as well as possessing a knowledge of comparative anatomy which enabled them to determine to what order of animals the huge bones they found belonged, the Maori fathers were also acute geologists, but it seems more likely that the poetical story of the quarrel between the three brother gods of the volcanoes of Ruapehu, Tongariro, and Taranaki, and the flight of the latter down to the plain which now bears his name, tearing up as he fled the deep gorge of the Whanganui River, the taking of the remarkable truncated cone of Rangitoto from the lake on the northern shore of Auckland harbour, and other similar legends, have reference to memories of great disturbances witnessed by their ancestors at nearer and more remote epochs. Such as that when a violent eruption of Mount Egmont took place, and the altitude of its cone was increased, and when the peak of the third great volcano of the group that once stood upon "that huge flat cone," the sterile pumice-stone plateau of Taupo sank down into the depths of the geyser-circled lake, as Arid Island has done in the Hauraki Gulf, or was blown up as Papandayang was in the last century,

leaving also a great lake to mark its site. This old volcano of Arid Island, with an area of some six miles in diameter, has subsided to the extent of at least 2,000 feet, Captain Hutton estimates, since the period when its lavas flowed over that portion of the adjacent country now known as Barren Island.

The events to which their traditions relate took place perhaps at a time when the stepping stones from New Zealand to the more ancient home of the Maori may not have been so far apart as they are to-day—as far back, it may be, as the time when the skeletons of men of this most ancient type, now from time to time exhumed from their graves, deep in the solid limestone rock, and covered with the ashes of long quiescent craters, lay bleaching on the coral strand of Oahu.

As for Rangitoto, its name is an evidence that the natives have seen the skies ruddy with its flames, reflected in the Waitemata—"the glittering waters,"—as in their usual expressive, and often poetical phraseology they have called the arm of the sea which surrounds it with such beauty. This impression has received strong confirmation by a discovery, of which the following notice is copied from the Auckland *Southern Cross* newspaper. The correctness of the description of the locality is established by the careful examination of the spot by Mr. Theophilus Heale, Inspector of Surveys, a gentleman whose scientific acquirements are well known, who informed me that there could be no doubt upon the matter, and that the conjecture that a landslip had occurred there, was without foundation :—

"An exceedingly interesting relic of the very remote past is now to be seen in the office of the Improvement Commissioners. It is the root of a tree found in one of the cuttings being made under the direction of that Commission. The root has evidently been chopped through by a stone adze which was found beside it. There were also several small branches and roots of the same tree on which the edge of the stone adze had been tried, and the whole crown of the stump had the marks of having been laboriously and patiently cut through by the rude stone implement in the unknown past, and by one of an equally unknown race of human beings. The root was found when cutting the sewer up the middle of Coburg Street, near the lower end, a little above its junction with the continuation of Wellesley Street, and at a depth of about 25 feet below the original surface of the Barrack Hill at that place. From the surface downwards for about 14 feet, at the place where the root was found, the hill is composed of volcanic matter. Below that depth, for about 8 or 9 feet, there is a series of layers of a mixture of sand and clay, which appears to have been at one time deposited under water. Below that is a large bed of fine blue washdirt resembling blue clay. These strata and the blue clay do not seem to have been at all disturbed by volcanic action, and

the several strata are lying with the utmost regularity possible. It was in the upper portion of the bed of blue clay that the root was found embedded, standing upright as if it had grown there, and the several small branches which were found at the same place were of the same kind of timber, and bore plain and distinct marks of the stone implement upon them. The inference to be drawn is not only that the islands of New Zealand had been inhabited long anterior to the migration of the Maoris to them, but that they had been peopled before the extinct volcano in the neighbourhood of the present Mechanics' Institute had begun to belch its mud torrents and streams of melted lava. This conlusion seems to be inevitable, whether it be assumed that the tree grew where the root and the implement of its destruction were, or whether, as some incline to think, a river had run where the blue stratum is found, and that the root had been carried from a distance to its resting place. In either case the root must have been where it was found the other day, not only before the volcanic matter was deposited on the Barrack Hill, but for a sufficiently long period before that to permit a stratum of 8 to 10 feet in thickness to be deposited."

The conclusion that the volcano was in a state of activity long after the tree was felled seems beyond contradiction, but that the hand that used the stone adze, with which it was laboriously cut down, was not that of a Maori is by no means a *sequitur*.

With respect to the old trachytic volcano of Taranaki, whose far stretching, symmetrically sloping buttresses, have guarded for vast ages from destruction by the ocean the tertiary deposits which fringe its eastern and southern base, and lie up to the flanks of Ruapehu and the ranges of the Ruahine and Kaimanawa, as strata of similar age cling like coral reefs, Mr. Jukes says, to those of the volcanic islands to the north of Australia, especially in the Timor Sea, it appears quite possible that considerable changes in its contour may have been witnessed by the remote progenitors of the present aborigines, at an era not perhaps more distant than that when the second city built upon the same spot was buried under the ashes of Vesuvius. Its crater not having sunk in, Mount Egmont does not present in a truncated cone the evidence of the changes in its appearance since it and its loftier rival Ruapehu stood also, perhaps, islands in the tertiary sea. From a platform, as described by Dr. Dieffenbach, at an elevation of about 5,800 feet above the sea the present crater cone rises, its cinders and slags of scoriaceous lavas cannot be distinguished in their lithological character from those of the more recent eruptions of the volcanos of Auvergne, which Mr. Scrope assigns to a date subsequent to the appearance of man in that region.

During the past summer there was less snow upon the mountain than has ever been the case before since the settlement of New Plymouth was founded—

indeed from that place scarce any was visible—and the ascent of the upper portion of the peak was made over scoria and ashes loose as those of the summit of Vesuvius. By rolling stones down into deep clefts or crevasses in the frozen snow and ice which fill the basin of the crater a good estimate could be formed of the great profundity of the abyss.

Whether witnessed by the Maori or not, from the materials which compose it and the small amount of dilapidation its peak has undergone, there seems no reason to doubt the activity of Taranaki Mountain during the human epoch in the Polynesian seas. Old men of the present generation have seen great changes in the aspect of a portion of the Savaii (the Samoan Hawaiki). Were the gently swelling plain of Matauto in that island—now dotted round with the villages of the natives amidst the groves by its margin, and covered with lavas which flowed early in the present century, so rent and fissured that it is next to impossible to reach their source in the deep sunken crater in its centre, the walls of which do not rise above the level of the surrounding sea of rocks—to be bulged up by degrees to a considerable elevation around the crater, and the huge angular masses of lava covered up with the showers of lapilli, volcanic sands, and torrents of moya ejected from time to time, it would present, on a lesser scale, much the same features, so far as the landscape is concerned, that Mount Egmont may have done to the first dwellers on the Waimate Plain, and when a higher crystalline cone is at length super-imposed, those which that stately mountain does now.

Persons who have no respect for the traditions of semi-barbarous men, forgetting how many of the most cherished beliefs of civilized peoples are founded entirely upon the ones handed down from the time when their own progenitors were in a similar condition, may smile at the production of such evidence, but as in the case of the Auckland volcano, proofs may yet be forthcoming of the correctness of the convictions of the natives.

Some time since a dispute occurred between the Taranaki and Puketapu tribes respecting the boundary line between their respective territories, and the claim of the latter to have it carried across the summit of the peak was resisted by their neighbours upon the ground that the original pahs of their ancestors lie deep buried on its slopes. The debate was long and eager, but the traditional evidences produced were in the end received by the Puketapus as establishing the right of the Taranaki chiefs to the whole area of the mountain which destroyed during the great eruption the villages on its flanks.

Many persons are under the impression that it is an accepted fact that the history of the Maori in these islands dates back only three or four hundred years. But it is not so. Mr. Hale, who accompanied the United States Expedition, and who made the ethnology of the Polynesians his especial study, gives three thousand years as the period which has probably elapsed since the

first migration of the ancestors of the Maori took place to their present abode. Mr. Colenso, also, in his able paper, in which he does the justice so few do to the native race, states his conviction that the time of the first peopling of New Zealand is one of high antiquity.

Their own mythical stories vary; the first discoverer of the country, according to one, was Ngahue, who returned to Hawaiki with glowing accounts of the island of great birds which he had found; another was Kupe, who, putting to sea in quest of his fugitive wife, returned unsuccessful in finding either her or his brother who had carried her off, but bringing to his countrymen the news of the great and fertile land, where he had rested for a time, for which the fleet of canoes conveying the earliest colonists shortly steered their course.

Genealogical traditions amongst all, even the most civilized nations, are notoriously the most uncertain; none, we know well, are more utterly fabulous than those gravely published by some in our own country, and it seems somewhat strange that the very same persons who persistently decline to receive those handed down by the Maori as evidence of the contemporaneous existence of the giant birds, and relating to other subjects, such as were most likely to make an indelible impression upon the minds of a comparatively uncivilized race, should insist upon implicit reliance being placed in their chronology, based as it is of course solely upon their genealogical trees—heraldic sticks literally—whilst they find no difficulty in making up their minds to admit with the majority of the thinking men of the age that the genealogical tables given in the Mosaic records are not to be taken as a measure of the time that elapsed between those stupendous events which closed the elephantine period—as Cuvier puts it—and the next and greatest era in the history of man.

If, as Mr. Hale thinks, the voyage of the Maori Jason was undertaken at a period equally remote as that of the Argonauts, we may well expect to find the substratum of truth upon which their stories rest overlaid with, at all events, an equal mass of fiction as that which surrounds the mythological tale of the classical Greeks; and we might indulge our imagination with the consideration of still greater changes than those that we may reasonably presume have occurred since the first emigrants from famed Hawaiki came to the land of the Moa, without placing that event at quite so remote a date as that distinguished philologist has done.

If these long centuries have indeed passed away since then, we might venture to picture the early Moa-hunters following their grand game over plains still lying fair to the rising sun—much farther than they do now—the remnant of those wide savannahs through which in times far more distant flowed that great river which received all the torrents coming down from the lofty cordillera, robed with glaciers proportionate to its then greater altitude,

from the Waitangi north to those swollen by the melting snows of the Ruahine, when Cook Strait with its picturesque sounds did not exist, but, as Mr. Crawford suggests, a river flowed to the east, carrying off the waters from the innumerable winding glens that pierced far into the recesses of the mountains.

Putting out from some bay in their large double canoes with matten sails, such as the voyagers came in from Hawaiki, and which were still in use amongst the Maori in Tasman's and Cook's time, some families of these Moa-hunters may have been carried by a strong westerly wind to the furthest outlier of the old land, now known as the Chatham Islands, where they still found a genial climate, and large birds of the Moa tribe to supply them with animal food,* and founded the colony of the Morioris, whom we find, as naturally would be expected, had degenerated from their long isolation in this limited country where the means of subsistence were less ample.

Referring to the speculations regarding times alluded to more remote, it certainly is much more agreeable, and at the same time more consistent with the evidences we possess, to reflect upon the possible beauties and grandeur of the scenery of New Zealand, and its fitness for animal life in the days when its glaciers reached their greatest extension, than to shudder at the picture of the great island of desolation with those who would envelope it in a fall of ice and snow. It seems scarcely possible to doubt the long gradual process of subsidence which has been going on for ages diminishing the area of this country, the evidences of which are greater as we go to the north and east, as might be expected in a region the foundations of which have been taken away by intense volcanic activity, with occasional local elevations in limited districts. But when we speculate upon its former extent and features we do so only upon probabilities; and, seeing how constantly the progress of discovery causes the abandonment of positions deemed to have been established, theories affecting scientific questions are not safely to be built upon such foundation. Nevertheless, there is no more reason for scepticism regarding the belief that the Moa may have wandered by the banks of the river that debouched in the longitude of the Chathams, than there is to doubt the conclusion of distin-

* My attention was drawn to the interesting fact of there having been large birds existing in the Chatham group in former times, by being told by a Maori, born in one of those islands, that large bones were found there; on my suggesting they might be seal's bones, he said, "No, big bird, all the same Moa." It appears that the Morioris have traditions about a great bird, called by them Puoa. Its remains are found from time to time; the last were discovered at Karewa, a place in the main Chatham, known to the natives as Warekauri—perhaps in memory of the use in the end made of the kauri canoe which brought the ancestors of the Morioris from New Zealand. The leg bones found at Karewa are stated to have been as thick as an average man's wrist. Mr. Shand, a gentleman who has resided there for twenty years, and understands the Moriori dialect, informs me that the name Puoa had reference to its cry, and is pronounced with a deep guttural sound. The Morioris have a song about it, and repeat the first syllable as a chorus, Pu, pu—Pu, pu—Pu, o-a, in a manner which recalls the hollow drumming noise made by the emu. The word is probably a contraction for Pu-pu-moa.

guished geologists that stone-axe-using men followed the mammoth and the reindeer through the forests of the Thames and the Humber, whilst these rivers joined the Rhine in its course to the Northern Sea.

My chief object in these notes is to draw attention to the interesting memorial of by-gone times: we have in this hewn tree, under the sedimentary and volcanic deposits at Auckland, a proof of the insecurity of hypotheses based upon the idea of the alleged short period the Maori has been here established.

In the papers published in Vol. IV. of the "Transactions of the New Zealand Institute," which contain such a large amount of most interesting information regarding the remains of the giant birds, and the old umus in the South Island, Dr. Haast, F.R.S., whilst he admits the occupation of the country by man in remote times, urges that the *Dinornis* was exterminated by the autochthones of New Zealand "long before the Maoris settled here."

That such a race may have existed it is impossible to disprove, especially if we consent to accept with him that the first Moa-hunters followed their game overland from Foveaux Strait to the North Cape; but they were certainly not surviving when the progenitors of the present aboriginal inhabitants arrived, otherwise their traditions would not be absolutely silent on the subject.

I may quite misunderstand Dr. Haast in presuming that he had changed his opinion as to this part of the question, but he concludes his third paper with a sentence which seems to indicate that he now thinks the Maori and the Moa-hunters were the same people. He says, "I have, as I believe, conclusively shown that the native race who hunted and exterminated the different species of *Dinornis* was a pre-historic people, and that the Maoris, the present aboriginal inhabitants of New Zealand, *probably the direct descendants of the former*, have not the least tradition about them."

If the Maori be of the same blood, the direct descendants of the Moa-hunters, who were, he says, "a people in such a low state of civilization that it is difficult to conceive they could have built canoes strong enough to cross Cook Strait," and therefore he is the more inclined to believe they were all to avail themselves of the overland communication, a most strange episode in the history of the human race is presented for our consideration; indeed the problem is distinctly proposed upon the following evidence by the same gentleman :—"I have," he says, "shown that long after the Moa-hunters had ceased to exist, this locality continued to be a favourite camping ground of succeeding generations, who in the course of ages became more civilized, as shown by their polished axes and more finished stone implements." So that the descendants of these savages, to whom the appellation of Moa-hunters is given as long as the great birds formed their principal support, who fell into so low a state as

to be even unacquainted with the art of polishing stone weapons, nevertheless, having in after times returned to agricultural pursuits, and taken to cannibalism, regained most of the remnants of that peculiar phase of civilization once prevailing amongst their still remoter ancestors, as well as amongst the allied races in the Samoan, Friendly, Sandwich, and other groups of islands tenanted by the Polynesians—such as the system of *taboo*—the inheritance of lands passing through females, etc.,—and presenting on the arrival of the Europeans equally fine physical characteristics, with a language little altered, and retaining the same or very similar traditions; those strangely interesting monuments of the more advanced state to which the progenitors of this widely scattered race had attained in the country from which they originally came.

It is considered by many of the ablest students of ethnology that the Polynesian belongs to one of the most ancient and well marked families of man, and certainly if the ancestors of this branch from the main stem were settled here before the islands were severed, a far more exalted antiquity is probably claimed for the Maori than even Mr. Hale proposes.

In adverting to the subjects touched upon in this paper, it is also with the hope that whilst some of the old men remain, with whom traditions may have lingered, affording valuable evidence possibly of the more ancient as well as recent changes in the configuration of the country which may be of service to our engineers, and also respecting its natural history, those who have the opportunity may endeavour to obtain all the information to be gathered bearing upon these interesting subjects, ere the chance of doing so is gone for ever, and more of its ancient denizens have passed away unknown—as the *Notornis* would have done but for Mr. Mantell.

Within the last seven years, in the wooded ranges behind Opotiki, a bird was killed, which, the natives say, used to be common and esteemed, unluckily for itself, a great delicacy; it resembled a goose in shape, with rufous plumage; being unable to fly, it was caught with dogs. My informant, who casually mentioned the circumstance, was there at the time, and never having heard of the *Cnemiornis,* and not taking particular interest in such matters, was surprised at my evincing so much interest in his report of the existence of this, its probable still living congener. Very lately, too, at the edge of the forest, on the upper Whanganui, it is rumoured that a strange bird was seen which may belong to the same species.

In the recesses of the vast forests of the North Island, impenetrable to man, unless with time and labour expended in cutting a pathway through the dense undergrowth, it is quite possible that wingless birds may still survive, once familiar to the natives, but not mentioned by them to us in consequence of their being nearly forgotten from their rarity—being chiefly nocturnal in their habits they seldom stand the risk of being disturbed by the few chance

travellers on the narrow paths not often traversed; and they might still remain for long were it not for the destructive animals that have come with the Europeans. Rats have committed great havoc, amongst those especially which lay their eggs upon the ground, and wild cats have found their way into the very depths of the forests.

It is difficult—almost hopeless now—to obtain any remains of the Solitaire, still more so of the Dodo, birds a century or two ago plentiful enough to be caught for food by sailors frequenting the islands they inhabited. So it will soon be with the *Apteryx* in the South Island, and, as Mr. Buller says, the last *Apteryx oweni* may go into a "gold-digger's pie." There are persons who earn a livelihood yet by catching "Maori hens," as they call them, and destroy hundreds for the purpose of providing these luxuries. There may be some excuse for the hungry miner, but none for the epicures of our towns who encourage the destruction of the beautiful tui, hung up in numbers for sale in the open light of day.

The New Zealand Institute, under the able superintendence of its accomplished and energetic Director, Dr. Hector, F.R.S., has done much; its "Transactions" have made New Zealand known more in foreign lands than it otherwise would have been, and have gone far to redeem the colonists from the character attributed to them by more than one writer, of being a community entirely absorbed in the pursuit of gain. Now is the time, when peace prevails, and interest in things of the past is not totally lost amongst the Maori themselves, for all its members, who have the opportunity, to exert themselves in this direction.

Much might be done, possibly many old memorials which might throw light upon the past might be rescued from oblivion, were the agents now employed in all parts of this island instructed to avail themselves of the opportunity afforded by their intimate communication with the elders of the different tribes, whilst carrying out negotiations for the purchase of their ancestral domains, to obtain all the information practicable regarding subjects of interest to the world at large. The memory of such useful labours will secure the gratitude of future generations to this when all its other doings are utterly forgotten.

ART. IX.—*Notes on Maori Traditions of the Moa.* By J. W. HAMILTON.

[*Read before the Wellington Philosophical Society, 8th August,* 1874.]

IN 1844, at Wellington, I was present, as Governor Fitzroy's private secretary, at a conversation held with a very old Maori, who asserted that he had seen Captain Cook. Major Richmond, then the Superintendent of Wellington, or rather of the Southern Districts of New Zealand, was, I think, also present. I cannot recollect who was the Governor's interpreter. This Maori,* so far as my memory now serves me, I should guess was 70 years old, at all events he was brought forward as one of the oldest of his people then residing about Port Nicholson. Being asked had he ever seen a Moa, he replied, "yes, he had seen the last one that had been heard of." When questioned as to what it was like, he described it as a very large, tall, bird, with a neck like a horse's neck; at the same time he made a long upward stroke in the air with his right hand, raising it far above his head, and so as to suggest a very fair idea of the shape of a Moa's neck and head, such as I have since seen them in the skeleton birds of the magnificent collection which Dr. Julius Haast has gathered together in the Canterbury Museum.

There is no bird or animal of large size indigenous to New Zealand to which the old Maori could liken the Moa. The horse was probably the only creature imported by us in 1844, in which he could possibly find any kind of likeness calculated to give *us* a fair general idea of the shape and height of the bird's neck and head. Possibly the old man did not speak the exact truth. But, if he had never himself seen a Moa, how—unless he had received its description handed down from Maoris who had seen one—could he possibly have hit upon such an idea as to refer us to the tall arched neck of the horse for a likeness? The gesture which he made with his hand remains impressed upon my memory as freshly as if seen only yesterday, as one that was singularly descriptive. It was like a sketch being made, as it were, in the air. Had the Maoris been noted for their curiosity respecting fossils or old bones lying about the country, one might surmise that the tolerably perfect skeleton of the bird may at times have been noticed by them on the surface. But, to this day, I have never heard of any Maori taking the trouble to lay bare any Moa skeleton partly or entirely covered up.

In 1844, and for many years later, it was believed by our people for a certainty that the Moa was still to be found alive in the South Island, of which very little was then known, otherwise Governor Fitzroy, who was fond of natural science, would, I am sure, have questioned the old Maori minutely and at length on the subject. In those days the names of one or two old sealers, who in the south, about Otago and Foveaux Strait, had, it was said, actually

* Haumatangi.—ED.

eaten Moa-flesh, were to my knowledge currently mentioned. One of these sealers was named Meurant. He was well known about Otago.

In 1844 little was known among the European population of the existence of Moa-bones, and very few had as yet been found. But the Maoris always knew them when they saw them. It is a curious fact to note that they should have a name for the extinct bird's bones if it had never been known to their ancestors as a living bird. I never heard a Maori give a name to any fossil, a shell for instance, and they always used to ridicule our exploring parties for carrying about useless stones, when fossils were collected by us.

In 1850 H.M. steam surveying ship "Acheron" arrived at Port Cooper, now Port Lyttelton. Captain Frederick J. O. Evans, one of the surveying officers, then master of the ship and now Hydrographer to the Admiralty, discovered, a mile above Sumner, on the Heathcote and Avon estuary, a cave which he called Moa-bone Cave. The name is well known now in Canterbury. From this cave he carried on board the "Acheron" a large number of Moa-bones. But with them were some few other bones, about which neither Dr. Lyall nor Dr. Forbes, the ship's surgeons (engaged also respectively as botanist and geologist) could make up their minds. On my return to the "Acheron," from an expedition inland to the Hurunui, the bones were shown to my Maori guide and travelling companion, Hone Paratene, (John Patterson) lately a Member of the House of Representatives. As they were being handed to him one by one he pronounced them unhesitatingly to be Moa-bones. Presently he stopped at one which had puzzled the doctors. He said he was "raru-raru" (puzzled, confused or doubtful) about them. At last, after some time spent in examining and thinking and turning it over, he said it was a seal's bone. The two doctors then at once recognised it as such. It is remarkable that, as the rest of the bones were handed to him, Hone only hesitated at those about which the doctors had also been doubtful.

In 1849, when exploring inland between Jacobs River, Tuturau, and the Molyneux, I engaged, either from the Bluff or the Maori pah, at the eastern entrance of New River (Oreti), a Maori named Wera or Whera. He told me that in olden times, *i.e.*, before his day, they used to drive a stout post into the ground above the entrance of a cave and to hang from it a rope with a slip-knot. By this the Moa would be caught when passing into or out of the cave. If not absolutely true, the statement is at least curious from its coinciding with the fact that it is so common to find quantities of Moa-bones in caves.

Mr. William Guise Brittan, the Commissioner of Crown Lands, states that when he arrived in 1850 with the first Canterbury settlers, one of the Rapaki Maoris told him that before he, the informant, was born his father had hunted the Moa. Should I hereafter recall to mind any other particulars I may have heard formerly respecting the Moa, you shall have them.

ART. X.—*Description of the Moa Swamp at Hamilton.* By B. S. BOOTH. Communicated by Captain HUTTON.

Plate V.

[*Read before the Otago Institute, 12th October,* 1874.]

SOME four years ago, one of the company called the Cornish Gold Mining Company, when cutting peat, uncovered a few bones, and thinking it rather strange that so many should be together, he came to me and related his discovery.

I immediately went to the place and sunk a hole 4 feet square, out of which I took 56 leg bones, and others in proportion, and then had not bottomed it in consequence of water. I at once saw the importance of the discovery.

Knowing that it was on the Cornishmen's claim I said nothing about it, thinking that they might move their pegs, and that I would then see what could be done. I believe this was long before Dr. Haast's discovery of a similar nature in Canterbury. In December, 1873, I found that the company, in pegging off a new claim, had left the pit outside their boundary.

I then called the attention of the editor of the *Mount Ida Chronicle* to the deposit. He inserted a note in his paper; the daily *Times* copied it; Captain Hutton's eye met it; and on the 15th of January, 1874, he was on the ground, when he made arrangements with me to commence researches.

I found it to be a dry lagoon of a slightly oblong shape, 45 by 50 feet, situated on the lower edge of a flat piece of ground.

For some 200 yards on the sides and upper end the ground was quite level.

The lower alluvial stratum of the flat, as well as of the spurs surrounding it, is, for a depth of from 10 to 30 feet, composed chiefly of water-worn quartz pebbles. The lagoon is from 1 to 5 feet deep, gradually sloping in from the rim of the basin to a point in the north-east quarter, which was near the centre of the bone deposit, and which appeared to have been a spring up to the time that the water had been drawn off by cuttings in the Cornishmen's claim. Notwithstanding this cutting, within 30 yards of my hole, and 20 feet deep, the water rose 1 foot when tapped, and stands there still. The basin lies in a bed of bluish sandy micaceous clay, which clay is from 2 to 8 feet deep, and rests on the gravel spoken of above, which, according to the face in the claim, must run 20 or 25 feet deeper. The surface of the lagoon, before being disturbed, was rather higher than the surrounding surface, and consisted of from 1 to 2 feet of black peat mixed with a blackish silt which rested on and was mixed with the bones to the very bottom.

The bottom of the lagoon is lined about 1 foot thick with a fine whitish clay, very soft, and somewhat elastic.

In streaks and patches in this clay a red substance occurs at from 1 to 3 inches in thickness.

The red streaks could be traced to the spring where, from top to bottom, everything was discoloured with it.

Through the rim of the basin, on the north-west quarter, there has been an outlet, within 1 foot, as deep as the deepest part of the lagoon.

This outlet is filled with peat from top to bottom, showing plainly that the lagoon had an outlet, but no inlet can be found.

It appears to me that the basin must have been formed whilst it was yet under water near the shore of a great lake.

The spring water rising would not have allowed the precipitation of the fine particles which form the blue clay in which the basin is situated, and when the lake receded it cut its outlet to the lowest ground.

The bones were deposited principally in the north-east part of the lagoon, on a space exactly the shape of a half-moon, 40 feet from point to point, 18 feet across the centre, and varying from 2 to 4 feet deep. Out of this small space there were, when packed, 7 tons weight, and if half be allowed for packing material, it would leave 3½ tons of bones, and we judged that about half were thrown away as being too much decayed for any practical use. They lay in every imaginable complication of tangle, which Captain Hutton most comprehensively described by saying, "There is no bone on the top." The greater part of them were so completely decayed that it would be impossible to make even an approximate estimation of the number of birds that had fallen in this place, and centuries must have passed whilst they were in course of accumulation. However, Mr. Edmonds and myself consulted on the matter, and concluded that there could not have been less than 400.

There were no bones of young birds near the top of the deposit. This I will account for hereafter.

There were also a large number of bones that had been broken and healed. Also a considerable number of the extinct goose (*Cnemiornis*), a few of the eagle (*Harpagornis*), a few reptiles, several of different species of small birds, and a single jawbone of a rat. A disease of the foot appeared to have been very prevalent amongst them, as a great number of the joints presented unmistakable indications of rot, so much so that some of the toe joints had even grown together. On the whole they were in every stage of decay, from sound bones down to bone-dust, sound on the top, and the deeper the more decayed.

In the north-east part of the lagoon, close to the edge, in the very shallowest

part of the deposit, there was a patch of pelves, with very few other bones mixed with them. This I shall account for further on.

A great quantity of quartz gravel and smooth pebbles occurred amongst the bones and in the shallowest parts of the deposit, under a pelvis or breast bone, which had not been disturbed; they lay in bunches, just as though they had been placed there with a pint measure.

There was no gravel in the lagoon except amongst the bones, and no small gutter or water-course could be found by which it might have come in. There were five or six smooth quartz stones, from one to two pounds each, lying under the bones on the soft clay, and one piece of rock, 10lbs. or 12lbs. weight, lying higher up on a firmer bottom. Also several pieces of split sticks were found on the bottom, which I laid by, but some person must have taken them away for fuel.

So numerous have been the opinions given and theories advanced regarding the cause of this deposit, that I shall be obliged to make a passing note of them all, in order that I may the more clearly lay before you my humble views on the subject.

As being brought together by water appears to be a favourite theory, I shall first endeavour to show, by the following reasons, that such is not within the bounds of probability.

It is quite patent that water could not have lodged them there without there having been a channel and a strong current, and even so, they must have been brought a long distance for such a large number to be collected together.

There being no inlet through the rim of the basin, and no watercourse to be traced in any direction as a feeder, I cannot see how water could possibly have lodged the bones there. It certainly would have left some trace as to where it came from.

The pit being on nearly a level flat, it would be an outrage on human reason to suppose the bones to have come tumbling in from every direction to this one small hole, and none of them have lodged in any of the numerous lagoons surrounding it, all of which I have searched in vain to find bones or the red oxide. Water moving with force enough to carry and place these massive bones in such a heap would not have allowed the light silt or sediment to have precipitated, but would have carried it onward, and instead of light silt, we would have found amongst the bones coarse shingle, roots of wood, every description of *dêbris*, and even boulders.

The greater part of the bones would have been ground to dust, and those that remained would have shown unmistakable signs of having travelled a rough journey; but the bones presented not the slightest appearance of having been waterworn, or even moved from the place where they first fell. Even bones not larger than a sail-needle were quite perfect, and would it not be

madness to suppose that bones of this description would tumble along on the bottom of a gully, amongst stones of various size and weight, and not be broken or ground to powder. It appears to me that even to imagine this deposit to have been made by water would be to imagine an impossibility.

You might ask me how then did the fine gravel and pebbles come amongst the bones, and why was it so evenly distributed through the greater part of the deposit? I answer, by one of two ways: It has either been brought by the water from the bed of gravel underneath, or has been in the bodies of the birds when they fell. I must say that, for the following reasons, it almost amounts to a conviction with me that the latter was the case. Considering that immediately over the spring, for a depth of 3 feet, the bones were packed in as tight as though they had been trampled in by horses, I fail to see how the pebbles and gravel could have been forced up by the water. Again, this gravel being deposited in small bunches or heaps on the top, where they mostly occurred, and as those bunches were invariably sheltered from top disturbance by a pelvis or breast bone, it appears most reasonable to me to suppose that these deposits came in from the top. Where these bunches were sheltered, or could not be disturbed from the top, they lay as they had dropped, but where unsheltered they became scattered and equally distributed amongst the bones. The disturbing causes I shall explain presently. Again, it is a remarkable fact that in the bogs and peat, where the sluicers came on large bones, this peculiar white gravel always occurred; in no other place in the claim was it to be found mixed with the peat. I have myself cut peat in the same place, and do not recollect having seen a particle of gravel. Furthermore, it is generally remarked that about the ranges where the remains of the Moa are found these white pebbles are almost invariably in close proximity.

However, I must leave this phenomenon, as requiring more light for a solution.

I must confess that when first commencing to open up the pit I could see no other cause for the deposit of bones than that savages had placed them there. But during further progress of the work I was involuntarily obliged to abandon my favourite theory.

It is true this hypothesis seems very possible, and even feasible, and many reasons can be adduced to show that this might have been the case, but when all the arguments are summed up, they stand unsupported by a single fact in connection with the subject under consideration, for not the slightest indication of human agency could be detected during the whole course of exhumation. If these bones had passed through the hands of savages, the rude stone implements used by them in those early periods, for the cutting of flesh and the breaking of bones, would have left some marks. Amongst so many hundred bones some of them would have borne the marks of a sharp edge, a hack, a

scratch, or a fracture. Some of them would have been split or chipped, or even broken to pieces for the marrow—that is, if they had marrow in their bones—and as they were a flightless and even wingless bird I believe it would be difficult to prove that their bones did not at least contain a little oily matter, which would be a sufficient inducement for the savage to break them and suck it out. But to grant that they had none does not alter the force of the argument. The pelves are so peculiarly formed on the inside, with covered-in hollows, that each one must have contained enough succulent matter to feed half a dozen savages. This the savages would not have allowed to be wasted, and they could not get it out without splitting or breaking the bones in pieces. In my view it is conclusive that if savages were the agents there would not have been a whole pelvis in the entire deposit. Again, we know with what extreme partiality savages regard the brain of man or beast; this proclivity, I believe, is universal with all the savages in the world. I know that amongst the scores of tribes that I have travelled through in different countries, and in several instances lived for some time amongst, I have never known them to lose the brain of the smallest bird or quadruped. They would invariably break the skull and suck out the brain or eat skull and all. Now amongst 60 or 70 skull bones that I obtained there was not one that appeared to have been broken for such a purpose. Where the cavity of the brain had been opened it was easy to tell that natural decay had been the cause.

Although I could adduce reasons for supposing that they might throw large bones into the waterhole, still I cannot see what would cause them to gather up bones about their camp not larger than sail needles, carry them to a waterhole, and throw them in.

Again, during the long time that must have elapsed to make such a large deposit, perhaps many hundred years, and the many thousands of times that the tribes and the different generations of tribes would have frequented this lagoon, it is quite rational to suppose that some relic, some toy or trinket, some implement, some weapon, or bones of man or dog (as Dr. Hector says they had dogs) would accidentally have fallen in the waterhole, and remained to be taken out with the general deposit.

As regards the burnt appearance of a great number of the bones, I am decidedly of opinion that it was caused by the red earth, or oxide, as it was only where they lay in contact with this earth that they presented such an indication.

The split sticks found under the bones were not sufficiently indicative of human agency to cause remark. How the half-dozen round stones and the single large stone got there I must leave a problem.

The theory of the birds having been bogged appears extremely problematical to me.

There was only about one foot of soft clay under the bones, and in some places the bottom was quite hard.

Even allowing that it was possible for some of the first birds that got in to stick in that thin layer of clay, when the bottom became covered and firmly packed in with bones to the thickness of one foot upwards, their feet could not settle down in the mud. This layer of bones of all sizes would be the same as if small pieces of wood and brush had been firmly packed in together, thus a solid bottom would have been formed, and I cannot see how it would be possible for any more to stick fast.

Again, there was a large number of goose bones in the deposit, and which appeared to be most plentiful near the top, and for geese to get bogged in a waterhole with a solid bottom of bones is something that needs a more intellectual comprehension than my own to understand. Then, again, the lay of the bones would, to a great extent, indicate the way in which they were deposited.

We cannot help supposing that if birds of this immense size and weight had been stuck fast in the mud, the lower end of the long thigh bones, as well as of the feet bones, would, as a rule, have been pressed deepest in the mud, and as the flesh rotted away they would have remained so. They would have to be pressed in very deep and firm to hold a bird, which was, perhaps, as strong as a horse.

For information on this point I took the lay of a number of bones, in a space of about 4 feet, from top to bottom, with the following result:—

Thigh Bones (Tibia).

Laid horizontal	30
Ankle end lowest	26
Ankle end highest	15
Total	71

Feet Bones (Metatarsus).

Horizontal	14
Claw end lowest	13
Claw end highest	11
Total	38

The difference, you will observe, is so trifling that no basis for a calculation can be formed.

Then, again, supposing them to have been bogged, it would have been a natural result for some of them to have got in this trap when in a state of gestation, and egg-shells would have been mixed with the bones. I instituted the most scrutinizing search for them, and told the boy that I would cover

Tail Race.
Cornishman's Claim.
10 5 0 10 20
Scale of Yards.
PLAN OF MOA SWAMP AT HAMILTON.
— Bone deposit.
The figures denote the thickness of the bone deposit in feet.
Outlet.
A
B
FLAT
2 2 3 3 6 4 4 4 5 2 2
Shallow: no bones.
Spring.
A
B
Turf.
Peat with bones.
Clay.
Gravel.
SECTION on PLAN A.B.
To accompany Paper by B. S. Booth.

with shilling pieces all the egg-shells that he could find, and notwithstanding this close scrutiny, not the slightest piece of an egg-shell did we find.

Further, all animals have a remarkable instinct for avoiding such places of danger; in fact, very often I have seen man, with his boasted knowledge, rush into places where he could only extricate himself with the greatest difficulty, when the animal that he was in pursuit of would go round.

Again, if these bog holes served as Moa traps they are traps that have been in existence as long as the Moa, and it does not seem possible to me for the Moa to have got a standing on the earth and increased when the earth was full of traps to destroy them.

Many people think that the Maoris burnt the country for the purpose of destroying the Moa, which, they say, carried off the children and ate them. With this opinion I do not agree, for the following reasons:—

First, if we can judge from the anatomy of the bird, from the shape of its beak, the form of its claws, and its general structure, we can come to no other conclusion than that it was not a bird of prey or flesh-eater. It could not with its straight bill tear a carcass into pieces.

Again, to make a wanton destruction of food, is not known to have been the custom of savages anywhere in the world.

In the great American buffalo country, which I have travelled through, the savages have a law which they strictly enforce, and with some tribes under severe penalties, that any savage who wounds a buffalo, though he may be amongst thousands, must not shoot an arrow in, or attempt in any way to kill another, until he has captured the one he wounded.

In the valley of the Sacramento they were never known to take more salmon than they wanted for present use, except when they were laying in their winter's stock.

When the old Eastern States were a wilderness the natives would not kill a young fawn, or disturb a bird whilst incubating, and would not knowingly destroy any animal in a state of gestation.

Even the low grade of savages in Victoria never kill more opossums than will supply them for a day or two.

So if the savages of New Zealand made a wholesale slaughter of the Moa by firing the country, burning and rushing them into waterholes by hundreds to die and rot, all I can say is they must have differed from every other type of savage in the known world.

If we can draw any conclusion from their allowing the few pigs (given to them by Captain Cook) to multiply and spread over the whole island, we could not do them the injustice of even supposing that they would wantonly destroy their chief source of subsistence by burning the country, driving their noble

game from existence, and reducing themselves to a comparative state of starvation.

But, say some, this was their mode of capturing them for food.

My answer is, then they would have taken them out of the waterhole, and the bones, instead of being found where they were, would have been scattered about the surface near their camping ground, or, if thrown into the pit, would have shown some marks of having been handled.

From the great preponderance of opinion in favour of fire as the agent, we would almost be led to think that this country had once been a perfect Gehenna. They say fire could occur from natural causes without the agency of savages, as by lightning, by meteors, by spontaneous combustion, and by volcanos. All this may be possible, but let us consider the circumstances attending such phenomena.

First, it being only in the chapter of accidents that fire would occur from such causes, we should naturally suppose they would be of very rare occurrence, so much so that we could not rationally suppose that the same thing would occur over and over again, often enough to cause such frequent slaughtering of birds in this small waterhole as to pack in their bones to a depth of from 2 to 4 feet deep.

Again, it would be very extraordinary for fire to surround any part of a country, and thus close the birds in.

Fire almost invariably runs in a face, and not fast enough to overtake birds with such long legs, that is if they were at all inclined to use them, and if anything would give them an inclination to use them it would be fire. Then, in such a case, for them to stop, gather in a small waterhole, and allow themselves to be thus smothered, would manifest an amount of stupidity that none of the brute creation has been known to possess. But, for argument's sake, allowing such to have been the case, for about 400 birds of this large size to have been roasted in so small a compass in one mob would be a physical impossibility, inasmuch as they would have made a pile 50 or 60 feet high and the unlikelihood of the same cause occurring often enough, with such long intervals, to complete such a work by tens or twenties, makes it appear so unnatural and inconsistent to me that I can only look on it as a vagary.

Again, as fire only occurs in the dry summer season, this would be the time of gestation, and the same as in the case of being bogged, we would expect egg-shells, not the smallest particle of which (as I have said before) could we find. Further, if fires were so frequent there would have been left about the surface pieces or particles of *charcoal;* this would, by the wind and sudden showers of rain, have made its way with other silt to the pit, but the same as in the case of the egg-shells, we failed to detect the smallest speck.

In view of all this I cannot possibly see how this deposit of bones could be made through the agency of fire.

The occcurrence of a poison spring is quite a favourite theory with several, but, as practical observation could not determine anything in this respect, I am sorry to say that I am not in a position to throw any light on the subject. I know that such springs do exist at the present time; and although it might be within the bounds of possibility for the water to lose its poisonous property and become wholesome water, yet it looks to be such an extraordinary and improbable change, that it scarcely appears to me worth discussing.

In 1849 I recollect having seen a spring that was called in my guide book "Arsenical Spring." As for any scientific facts concerning it—I am not in a position to make a statement. All I can say is that it is situated near the Rocky Mountains of America, on the route to California, discovered by John C. Fremont, and called the South Pass.

That the spring was poisonous I can vouch for from the fact that when I passed it there were lying in and around it 50 or 60 dead cattle, mules, and horses; none appeared to have got more than 50 yards away before falling; some lay in the water, and some half out. The water was limpid and, if I recollect right, of a bluish tint. Being in a hurry to make the next camping ground, as well as afraid that some of my own animals might get to it, after a very short stop I hurried away, and this is all I can tell you about it.

Alkali springs, or rather lagoons, as well as hot, boiling, and cold mineral springs, I passed in hundreds.

Now, as regards the spring in this bone pit having been poisonous, I think it just possible and worth investigating; and the only way I can see is for you to carefully analyse the earth I send you and see if any poisonous substances remain.*

A minute investigation of natural causes and effects is, in my view, the only rational way of coming to a satisfactory solution of this great Moa problem. And, in order to fully explain my views, I shall commence by stating that in my opinion the cause of the deposit of bones at this place and the cause of the extinction of the Moa was one and the same. I cannot, therefore, very well confine myself to one subject without running into the other, hence it will perhaps be as well for me to make one subject of it.

That the Moa once existed we can place as a fact; we know that by its remains. That it does not exist now we can place as another fact; this its absence proves. That it could not now exist in this country there is, in my view, abundant proof to place as a third fact.

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* Dr. Black has analysed the "red earth" from the spring, and finds that it consists entirely of peroxide of iron and clay, without a trace of arsenic or sulphur, or anything that would indicate that it had been deposited by a thermal spring.—F.W.H.

Thence it follows that the conditions forbidding their existence at the present time must have been the cause of their extinction, and in the course of their extinction their bones accumulated in this pit.

From facts that have come under my personal observation it appears to me that the Moa existed in extremely remote periods; so much so that my limited knowledge of the sciences will not furnish me with words to name the periods I refer to. The features of this country unmistakably indicate that it has at some remote period been a succession of lakes and islands. Now, at whatever time you place that period, I believe the Moa then existed. Immediately above Roxburgh, along the Molyneux, there is a flat, or terrace, four miles long by one mile wide; it has evidently been a lake, from the fact that the whole flat is a bed of shingle, to a depth in some places of 40 feet, and the same kind of deposit being found along the entire length of the Molyneux goes to show that it has been brought down by the river, lodged in this lake or basin, and formed a level surface under the water until such time as the obstructions below Roxburgh were removed; then the river gradually cut a channel through the flat, as well as many feet down into what we unscientific men call "bed-rock."

Some ten years ago, when searching for gold, I was driving a tunnel from the water's edge on this bed-rock, and under about 40 feet of shingle, on the very rock bottom, I came on the skeleton of a Moa.

I debated the subject in my own mind, as well as conversed with several intelligent men, as to how it possibly could have got there, and we could come to no other conclusion than that the carcass had been brought down by the rapid current of the river, and when it came in the still water of the then lake it sank to the bottom. That bottom being the bed-rock, and the 40 feet of shingle over the skeleton, would go to show that the lake was yet in its earliest period, as the filling-in process appears to have been just then commencing.

The same summer I was sinking a shaft on quite a level piece of ground, about half-way up Conroy's Gully, in the Dunstan district, and I went through a sort of ashy-looking clay all the way to the bed-rock, which was 20 feet deep, and on the rock I found pieces of Moa egg-shells, which I have now in my house.

From these facts I cannot but believe that the Moa existed in far earlier periods than is generally supposed. I shall now state a fact that has also come under my observation, as being strong circumstantial evidence that *at least in this locality* the extinction of the Moa took place far anterior to any time yet mentioned by any one.

I find below a certain level, that would leave the whole Maniototo plains under water, there are no Moa-bones to be found, with the exception of about

the mouths of the burns coming in from the hills, where the bones have been brought down by freshets. This is easy to determine by their waterworn appearance. This level would come to within one mile of Hamilton, a little below the place called "The Fortifications." The Sowburn would have been under water, the water would have been up to the mouth of Puketoitoi, at Murison's, and Naseby would have been just above the shore of the lake.

For about six miles I have examined the banks of the Sowburn, where it has cut a channel through the plain, with banks on one side or the other from 5 to 15 feet high, giving a splendid chance to see whether there are bones in the soil. I have also examined the banks of the Pigburn for the same distance, as well as a tail-race, one mile long, cut up from the Taieri near the Hamilton and Naseby crossing, and in all these banks I have yet to find the first Moa-bone. Equally unsuccessful was I in searching the banks of several burns on the other side of the Taieri.

I have crossed these plains in several different places, and do not recollect ever having seen a Moa-bone below the level spoken of.

I have also inquired of several shepherds who live on the plain, and who have walked over every acre of it, and none of them recollect having seen a Moa-bone below the level I have mentioned.

Even should an isolated skeleton be found it could be rationally accounted for by a carcass having been brought down into the lake by a burn, floated out and sunk. Now what does this fact point to?

The only answer I can give is that the Moa was extinct in this locality when the whole Maniototo Plain, from the level spoken of, was yet under water; and I am quite certain that investigation will yet determine that there are many more plains presenting the same indication.

My conclusions were on this point, however, greatly shaken when I subsequently found a seam of lignite at the water's edge of the Taieri River, for the supposition that the birds had been extinct long enough for this lignite to be formed could not be entertained. It then suddenly occurred to my mind that some six or seven years previously I had sunk a prospecting shaft 60 feet deep at the foot of the hills, not far from the lignite, and that the strata all lay at an angle of about 75 degrees, pitching down towards the river.

From this I came to the conclusion that it was not only possible, but quite probable, that this lignite had been formed at a far higher level, and had, in a comparatively recent period, sunk or slipped to its present level.

That this country was, at a not very distant period, a great deal warmer than it is now, I believe is not disputed, for there is irrefragable proof to that effect, and also that it has gradually cooled to what we find it.

Now, as there is incontrovertible proof that the bird flourished some thousands of years ago, when the temperature of the earth and atmosphere

was so much higher, it is easy to show that they could not multiply, or even exist, under the present temperature of the elements in this country.

Judging from the warm time in which they flourished most, as well as from their enormous size, and from the class of birds to which they belong, we can scarcely suppose that they incubated their own eggs, but that they must (like many species of birds at present in warm countries) have allowed the heat of the earth and atmosphere to do the work of incubation.

The Moa was not at all adapted for hatching its own eggs. Birds that do so make great use of their wings in covering their eggs ; in fact, in the act of hatching, wings appear to be indispensable, without them the heat of the body could not be kept in the nest, the cold air would circulate under through the body, scatter the heat, and kill the vitality of the egg; in fact, it is questionable whether a fowl without wings could produce the first stages of incubation in an egg.

Now the Moa is said to have been entirely wingless, if so, it is certain that they did not sit on their eggs.

Again, their enormous size and weight would make it a very awkward piece of work to sit on a nest of eggs, the shells of which are not more than the twentieth of an inch thick. Fancy a bullock or a horse of 400 lbs. or 500 lbs. weight getting down on such a nest of eggs, and you have a very good picture of the gigantic *Dinornis* doing the same. That the warmth of the earth and atmosphere incubated the eggs appears to me indisputable, and if an approximate period can be found when the earth and atmosphere became too cold to do so I place that as the commencement of the Moa's decline.

This, I am aware, would not take place at the same time all over the country. It would, of course, depend on the altitude. Here, I am told, we are at an altitude of about 2,000 feet, where the cold may have stopped their increase, and put an end to them many hundreds of years before the same cause would destroy them in a place like the valley of the Molyneux, where even at Clyde the river is only 600 feet above sea-level. Also, the further north, as in the North Island, the longer they would have held out.

Even at the present time, in many places in the country, as in the sand banks of the Molyneux, the atmosphere in the day time would be sufficiently warm to hatch the egg, but the cold night air would place life beyond resuscitation. When the frost and snow of winter began to set in, though far milder than now, it would have distressed the Moa, as on account of its great size it could not find shelter like smaller birds, hence it would select places where it found the most warmth.

The spring water in the bone-pit being of the same temperature as the earth, and far above freezing point (in fact, it may have been a thermal spring), when all round the bird could not put down its foot without being bitten with frost,

or without placing it in snow and ice, what would be more natural for them than to step in to this comparatively warm water, which, to some extent, would relieve their suffering from cold in their lower extremities. Thus, the period when frost and snow began to set in I place as the commencement of the deposit of bones in this pit. The accumulation would have been very gradual, perhaps for centuries, and the periodical deposits would only have increased at the same rate as the frost and snow. This process continuing, until not even in the most favoured places would their eggs hatch, and the last of their race were, therefore, doomed to annihilation, a period would arrive which must have been with the poor birds a time of indescribable suffering. Thus afflicted with pain, famishing with hunger (as whatever their food was it lay deep under the snow-mantle of the earth), and finding cruel nature arrayed against them, pinching their bodies with piercing winds, from which they had no shelter, and cutting their feet with ice and frost, were it only as an alleviation of pain when dying, I can see nothing more natural than for them to have plunged into this spring. The water being of the same temperature as the earth, would feel quite warm to them, and there being no inducement for them to get out, as their food was cut off, they would settle in deeper and deeper, and remain till numbness and hunger put an end to their suffering.

Hence I account for the bones being soundest on the top, as they would have been deposited so much later. Hence, also, I account for there being no bones of young birds on the top, as it was long after incubation ceased that the old family was gathered to its resting place. Hence I account for the absence of egg-shells, as these deposits only took place in the winter season, which was never the breeding season with the birds. And by the trampling round of the birds, when in the spring, I account for the equal distribution generally of the gravel amongst the bones ; the trampling being the disturbing cause from which alone some bunches of gravel from the gizzards escaped by being covered with a breast bone or pelvis. The patch of pelves I can only account for in this way :—That as year after year, when the water was yet deep, a few carcasses were decomposed on the top of the water, the heavy limbs would fall off and sink, and the pelves being very porous, with, perhaps, skin and thick feathers dried on the top by the sun, would lie on the surface of the water until driven up to the edge of the lagoon by the fierce south-west winds which still prevail here.

It might be asked, Why were all the bones in the one peculiarly shaped spot? why were they not distributed through the lagoon?

The only reason I can see is that the lagoon was there centuries before the deposit commenced, and probably before the Moa existed; and as the south-west side is the hill side, and the side from which the winds prevailed and surface water would come, it became filled in with dust and light silt, from that side

first, up to the deep half-moon-shaped spot where the spring would not allow the silt to precipitate, but would carry it off through the outlet, and that when the bone deposit commenced the waterhole was in this half-moon shape. If it is asked, why are there no bones in the surrounding lagoons? my answer is, that as they are all (as far as I have examined) surface lagoons, they would have been frozen over when the cold drove the birds into the spring water which never froze, and, as I have previously remarked, perhaps thermal.

As for the geese, it appears to me, from the skeleton, that they have been as much a land bird as a water-fowl. The bones of their body are not much larger than those of the domestic goose, especially the breast bone and pelvis. The keel of the breast bone is scarcely more than rudimentary. This differs from the breast bone of any water-fowl that has ever come under my observation. However, those better versed in ornithology than myself should settle this point. The hip and leg bones, in size and length, are immensely disproportionate to the bones of the body, that is, for a water-fowl, and are in every particular (excepting the loophole in the hind part of the foot joint) proportionately the same as that of the Moa. If water-fowl, their feet, when swimming, would have struck some 20 inches under the water, which, according to my limited knowledge of water-fowl, would have been altogether apart from the ordinary course of nature.

I must here record my humble opinion that they were not aquatic fowl. Therefore the same causes that extirpated the Moa would have exterminated them. Hence their bones in the pit with those of the Moa. Further, I believe that had they been transferred to a warmer climate at the time of their decline we would yet have had the noble birds living.

As for the few eagle bones, and bones of other small birds found in the deposit, I would think that (on account of the attraction offered to flesh-eaters by this long-standing meatshop) chance would be quite sufficient to account for their presence.

As the rat bone was found in the *dêbris* that had been wheeled out of the pit, and taken from the top to the bottom, it may have come from very near the surface where we found that rats had been burrowing in the bones; therefore the presence of rat bones in the pit cannot be taken as a proof that they were deposited contemporaneously with the Moa bones.

In order to give you a clear conception of the intensity of cold at some seasons of the year in the neighbourhood of the bone-pit, as well as to support my theory, I would refer you to the fact that in the winter of 1873 our mailman in coming over the ranges from the Hyde and Kyeburn Roads, past the bone-pit, got his feet so badly frost-bitten that he was two months in the hospital at Naseby in consequence.

In 1866 there was a fall of snow here 2 feet deep, and the ground did not

show for six weeks, whilst the ice on the lagoons was 5 inches thick. Fancy a Moa bird struggling for existence in such a time, foot-frozen and nothing to eat, and you must see that even a spring would be a haven to it.

Well may their bones be found about the country in clusters, where, for warmth, they have crowded together, and either been frozen, smothered, or starved, or, perhaps all three when overtaken by such storms.

The bones of thousands of sheep and wild pigs are found about the country deposited in like manner through the same cause.

Dr. Hector* mentions one fact, however, which is strong presumptive evidence in favour of my theory. He says, "The greatest number of Moa bones were found where rivers debouch on the plains." The same feature marks the creeks from the mountain slopes. This strengthens my views as to the Moa flourishing most at a very remote period, a period when nearly all these plains in the country were lakes.

The bones, being brought down by freshets, where the creeks debouched in the lakes would become embedded, and thus age after age continue to accumulate. But the doctor infers that these places were the camping grounds of the Moa-hunters, and that they caused the bones to be deposited there.

At Lake Wakatipu the doctor takes another view, and thinks the heaps of bones found there by him were caused by the "destroying element" fire. With all due deference to the learned gentleman's opinion, I cannot subscribe to his views, inasmuch as the bones being in heaps, and close under a precipitous ledge of rocks, it would be the very place that the Moas would have sought to shelter them from a cold snow storm, but notwithstanding they perished in clusters. This occurring periodically, perhaps for many years, would rationally account for the many distinct skeleton heaps found by the doctor in that place.

As to whether there are more bone pits of the same description, I say yes; they will be found in all parts of the country where living springs occur in places where the Moa made its haunts. But, as some springs may have spread over more ground and formed boggy places, just in proportion will the bones be more scattered, and they will not be found (with the exception perhaps of a few isolated skeletons) far from the fountain head, for the reason that the water would not go far from the fountain head before cooling and freezing, when there would be no inducement for the birds to go in. Other places where they will be found very plentiful, though more scattered, will be about spring creeks, such as Puketoitoi. The bones will be scattered and waterworn on account of freshets disturbing them, and perhaps, as at Puke-

* See Dr. Hector's paper on this subject, read at the Otago Institute, September, 1871.—Trans. N.Z. Inst., Vol. IV., p. 115.

toitoi, having brought them down on the edge of the plain, but it will yet be proved that the original deposits were near the source of the creeks where the water would have been warm and free from ice. It may not be out of place to mention (although I am not writing about eels) that at the present time there is a creek which empties into the Taieri River, at the very head of the Maniototo Plain, that for some distance from its source never freezes. The eels congregate there in June and remain all the winter. This proves that even the eels find relief from cold in spring water, and it is quite apparent that the Moa would have found even more relief than the eels, inasmuch as the contrast between cold and heat would not be so great between the water of the Taieri and that of the creek as it would be between hard frozen ice and snow and the spring water.

This is my theory as plainly as I am able to put it, and I should not consider it fair for any person to criticise it from a literary point of view, as I make no pretensions to being a scientist, nor yet even to having had a passable education, which is more my misfortune than my fault; my only guide is observation and the study of cause and effect.

Art. XI.—*Notice of the Earnscleugh Cave.* By Captain F. W. Hutton, F.G.S. *With Remarks on some of the more remarkable Moa Remains found in it.* By Professor Millen Coughtrey, M.D.

[*Read before the Otago Institute, 14th September,* 1874.]

During the course of last summer I twice visited this cave, accompanied on both occasions by Dr. A. T. Thomson, and although it has already been very well described by Dr. Thomson himself (Trans. N.Z. Inst., IV., p. 111), by the Hon. Captain Fraser (*ibid*, V., p. 102), and by Mr. Cockburn Hood (*ibid*, VI., p. 387), the importance of the subject will, I hope, be a sufficient excuse for my bringing it under your notice once more.

The rocks of the district are mica-schist, dipping 10° S.S.E., and the cave in question appears to have been formed by a gentle slipping of a portion of the rocks towards the valley of the Conroy, the dip not having been altered by the slip. The cave itself is very irregular in outline, but always narrow, and quite different in character from the ordinary caves found in limestone countries. At the furthest point that can be reached the cave communicates with the surface by means of a small opening in the roof, and it is continued still further on by a fissure too narrow to get into. This surface opening at the end, as well as the lateral opening mentioned by Captain Fraser, ensure thorough ventilation to the whole of the cave. The

inclination of the cave is rather steep, averaging perhaps 1 in 3 from the entrance to the extremity. The floor is filled to a considerable depth with fine micaceous sand, derived from the decomposition of the mica-schist rocks in the district, and it appears to be gradually filling up.

It is only in the upper part of the cave, near the entrance, and in the talus formed at the entrance by the *débris* fallen from above, that remains of *Dinornis* and *Cnemiornis* have been found, while the extremity of the cave contained a considerable number of bones of a duck,* belonging apparently to an extinct genus, together with its nests and eggs, and also a few bones of parrots, hawks, and other small birds which have not yet been examined. With these were also remains of rats, the tuatara (*Sphenodon punctatum*), and fragments of the egg-shell of the Moa and the jaw of a pleurodont lizard. A few of the wing bones of the duck still retain portions of skin and feathers attached to them, and many of both wing and leg bones are gnawed half through by rats. A portion of the skin of a rat was also found, but without any hair on it. This rat's skin, as well as the wing of the duck with skin attached was found under several inches of sand, and indeed I am not aware that any were found on the surface of the floor. In fact, the whole of these bones were mixed together in such a way as to lead to the conclusion that the rat and the duck were contemporaneous.

It may, I think, be taken as certain that the rocks on either side of the cave have not moved since the bones were deposited in it, and I quite agree with Dr. Thomson and Mr. Hood that the cave was never inhabited either by man or by the Moa. The ducks, however, must have lived in it, as they built their nests and laid their eggs there, and probably rats and the tuatara lived with them. I also agree with Captain Fraser that no storm water could have washed the Moa remains into the cave, and think that Mr. Hood's suggestion that the birds fell in accidentally and were unable to extricate themselves is the only possible explanation of the facts. The bones of the parrots and smaller birds may perhaps have been taken in by the rats.

I have already remarked that the cave is gradually filling up, owing to its steep inclination, and the fact that it is not yet filled up shows that its origin cannot date back for a very long period of time. The fact of the rats having gnawed the bones of the ducks shows that they were omnivorous, and therefore probably the brown rat (*Mus decumanus*), but it may be possible to determine this from the remains that they have left behind them, which are not, however, very numerous. The brown rat may have been introduced into this province by the whalers in the early part of this century, but it certainly

* This duck is about the size of *Anas superciliosa.* It has heavy legs, comparatively small wings, but with a well-developed keel to its sternum, and a remarkably short bill. The egg is ovoid and measures 2·6 inches in length by 1·75 inches in breadth.

could not have existed here previous to that. The remains of the rat appeared to me to be mixed up pell-mell with those of the duck, but as the surface of the floor had been disturbed by previous explorers the appearance may have been deceptive.

Whether the remains of *Cnemiornis* and the Moa are contemporaneous or not with those of the duck there is no direct evidence to show, as each are found at opposite ends of the cave; but as many of the Moa bones were found in the talus at the entrance of the cave, and others on the surface of the floor, there is no reason for supposing that they are older than those of the duck, while the bones of both appear to have lost an equal amount of organic matter. The Moa bones mentioned by Mr. Hood as occurring above those of the duck must, I think, have been moved down into that part of the cave by visitors. I never saw any in that position myself, although they occur abundantly in the upper part of the cave, and may, therefore, in one sense be said to lie above those of the duck, which are found only in the inner or lower part of the cave.

None of the Moa remains are marked by rats' teeth, and the only reason that I can offer in explanation of this is, that the fleshy remains of the Moa may have been covered up with sand.

In order to ascertain whether there was any special quality in the earth of the cave which would assist in preserving the skin and flesh of animals, Professor Black has kindly had analysed for me some of the micaceous sand from the floor of the cave, and a fragment of incrustation from the side, with the following results:—

The incrustation is simply a mixture of quartz-sand and carbonate of lime, containing particles of earthy matter and small fragments of mica-schist. The earth from the floor of the cave was a mixture of pulverised mica-schist (potash mica), fragments of bone, dry powdered clay, quartz-sand, fragments of the stems of plants, and portions of carbonate of lime. No soluble salt was found in the earth, except phosphates, derived no doubt from the bones. Professor Black adds, "I do not know of anything in the specimens analysed to account for the preservation of the organic matter of the Moa remains accompanying them. In this case there does not appear to have been an incrustation over the remains, and I am not aware that the remains have been petrified by the substitution of calcareous and siliceous matter for the original substance."

On the whole, I am inclined to think, notwithstanding the fact that at least three of the birds found in the cave belong to genera now extinct, that the weight of the evidence goes to show that these remains are not very old, and that probably they do not date further back than the commencement of the present century.

I may also mention that during the autumn the cave has been carefully cleared out by Mr. Martin for the Museum Committee, and that the whole of

the bones that he obtained have been deposited in the Otago Museum, together with all the more valuable Moa remains from the cave, which have been most liberally presented by Dr. A. T. Thomson.

Notes on the Anatomy of the Moa Remains found at Earnscleugh Cave, Alexandra. By MILLEN COUGHTREY.

(*To accompany Captain Hutton's Notes.*)

THE remains with which I am specially called upon to deal are—*a*, Moa's neck and skin; *b*, right femur and muscles; *c*, left fibula; *d*, left tibio-tarsus.

(*a*) *Moa's Neck.*

An excellent description of this specimen is given by Dr. Hector in the Trans. N.Z. Inst., Vol. IV., p. 115, to which I wish to add a few notes.

In that paper, fig. *a*, pl. 5, exhibits clearly the general characters and the form of the portion of the integument preserved.

The conical papillæ of the dermis vary in size and the distances of their approximations to one another.

Those on the dorsal and upper aspect of the neck, allowing for the wrinkling of the skin, are much closer together and smaller in size than those of the ventral surface and lower part of the specimen; the upper ones being 0·15 to 0·10 inches apart, the lower and ventral ones 0·2 inches apart.

Allowing for the due and consequent contraction of the skin from age and drying, we must regard the Moa as having possessed not a very thick coat of feathers.

The bifurcate calamus, showing the secondary after-shaft in the Moa's feathers, as depicted in fig. 2, pl. 5, *loc. cit.*, is very well seen in all the feathers of ventral surface of preparation, but this character is not so common to those of dorsal surface.

The soft parts still attached to the six cervical vertebræ are respectively—

1. Portions of the supra- and inter-spinous ligaments of four lower cervical vertebræ.*

2. Intervertebral ligaments and cartilages for the central and zygapophysial joints. Anterior common and capsular ligaments well seen.

3. The left moiety of deep cervical fascia.

4. On the outer surface of this fascia, and on the under surface of the skin, also in the interspaces between and around the transverse processes, are the remains of vascular tissue.

5. So far as it is possible to make out the following are the muscular attachments still remaining:—

* This is almost identical with Dr. Hector's description, plus the names of the parts left.

(a) Serratus Magnus Anticus.

That slip of this muscle in the struthious bird which is the homologue of Levator anguli scapulæ in flying birds.

Origin of digitation from the under surface of left transverse process of last cervical.

(b) Interspinales.

The four lowest between the spines five lowest cervical vertebræ.

(c) Longus Colli (Anticus).

The running origin of this muscle as it arises from the hypapophysial processes of the last two cervical vertebræ but one.

The other parts are indistinguishable.

The small bone (size 0·4 by 0·2 inch), mentioned by Dr. Hector as articulating with the first dorsal vertebra, but of which the fig. in pl. 5 is very misleading,* is of great morphological interest. For the under and posterior aspect of the tip of the transverse process of the first dorsal vertebra on both sides, presents a depression into which the above little bone and its companion of the opposite side would fit; and the opposing surfaces respectively of the depression and small bone present the characters of united osseous surfaces that in course of development would become joined together.

From the above reasons, and from the fact that it is in the dorsal region of the column where epiphyses of the transverse processes prevail, I would regard the above small bone as the epiphysial element of the left transverse process of the first dorsal vertebra.

The surface of this bone at present adhering to a tag of the deep cervical fascia is that with which the tubercular portion of the rib would articulate.

Epiphyses of the transverse processes are very rare in creatures below mammalia.

Right Femur.

Glutæus externus.

A strong tuft is left attached to a marked rough prominence 3 inches below the epitrochanterian ridge, well on the outer side of base of great trochanter, also 1·6 inches from the sharp margin which separates the pre- from the post-trochanterian ridge.

At this tuberosity the outermost limb of commencement of the rough striæ leading down to the ectocondylar fossa begins, the other limb commencing in a depression on the post-trochanteric region into which *Quadratus femoris* is inserted.

From the anterior margin of this same depression a sharply defined line

* This is not the bone mentioned by Dr. Hector, as that bone, Dr. Hector informs me, has been lost.—F. W. H.

runs directly down the outer surface of shaft of bone, and fades gradually on the posterior aspect of ectocondylar tuberosity.

Glutæus medius and *Glutæus quartus.*

The remains of these two muscles seem to me to be present in some muscular fibres still attached to the ectotrochanterian tuberosity and part of the depression behind this.

Glutæus quintus (Mayer).

On a plane below, but intermediate to the tuberosity to which *Glutæus externus* is attached, and the ectotrochanteric tuberosity, is a small depression of about one-third of an inch wide, and into it is inserted a slender tuft of tendon; which I take to belong to the above muscle.

Obturator internus.

The ectotrochanteric surface is divided into two portions by a well marked ridge curving from the posterior border of epitrochanteric margin downwards and forwards towards ectotrochanteric tuberosity, slightly above which it subsides.

The upper moiety of surface thus mapped out is smooth compared with the lower, and presents the appearance of once having been covered by bursal tissue. The lower and posterior moiety is elevated and depressed, likewise roughened for the insertion of muscles.

Now in the posterior half of the lower surface are two well marked vertical depressions, one situated slightly in front and above the other one. And it is in this anterior one we have remaining a strong tuft of tendon, which, from the direction of its fibres, I believe to have been the *Obturator internus.**

The posterior and lower one is that in which Professor Owen has located the insertion of the *Quadratus femoris.*

Iliacus internus.

At the lower part of the anterior surface of the neck of the femur, just where it merges into the pretrochanteric surface, is a marked roughness with several of the fibres of above-named muscle still attached to it.

This is very interesting, as proving conclusively that this slight rough prominence is the representative of the smaller trochanter in mammalia, as had been foreseen by Owen.

Cruræus, part of Vasti.

Arising partly from the under surface of the base of ectotrochanteric tuberosity, partly from the ridge beneath it to the extent of half-an-inch, and partly from the linear ridge of the pretrochanteric face in the vicinity of

* I am aware that Professor Owen has stated *Abductor magnus* is inserted into this depression, but he has not had any specimen in which tendon has been left.

above tuberosity, are some muscular fibres that run down over anterior surface of femur, as if the muscle when entire had ensheathed the shaft of the bone. These fibres, I think, belong to the *Vastus externus* or anterior part of *Cruræus.*

Left Fibula.

The strong firm attachment of tendon of *Biceps flexor cruris* is well seen inserted into a strong roughness about 2 inches below head of the fibula on its outer surface.

Left Tibio-tarsal Bone.

On this bone there is a small slip of tendinous insertion left, which I believe to be part of the *Sartorius.*

It is into a depression on the inner side of the procnemial ridge about 4 inches below the head of the tibia at the apex of that well-defined triangular surface on the inner and anterior aspect of the bone, from which the second head of origin of the *Gastrocnemius internus* arises.

Art. XII.—*On the Discovery of a cut Stump of a Tree, giving Evidence of the Existence of Man in New Zealand at or before the Volcanic Era.*

By John Goodall.

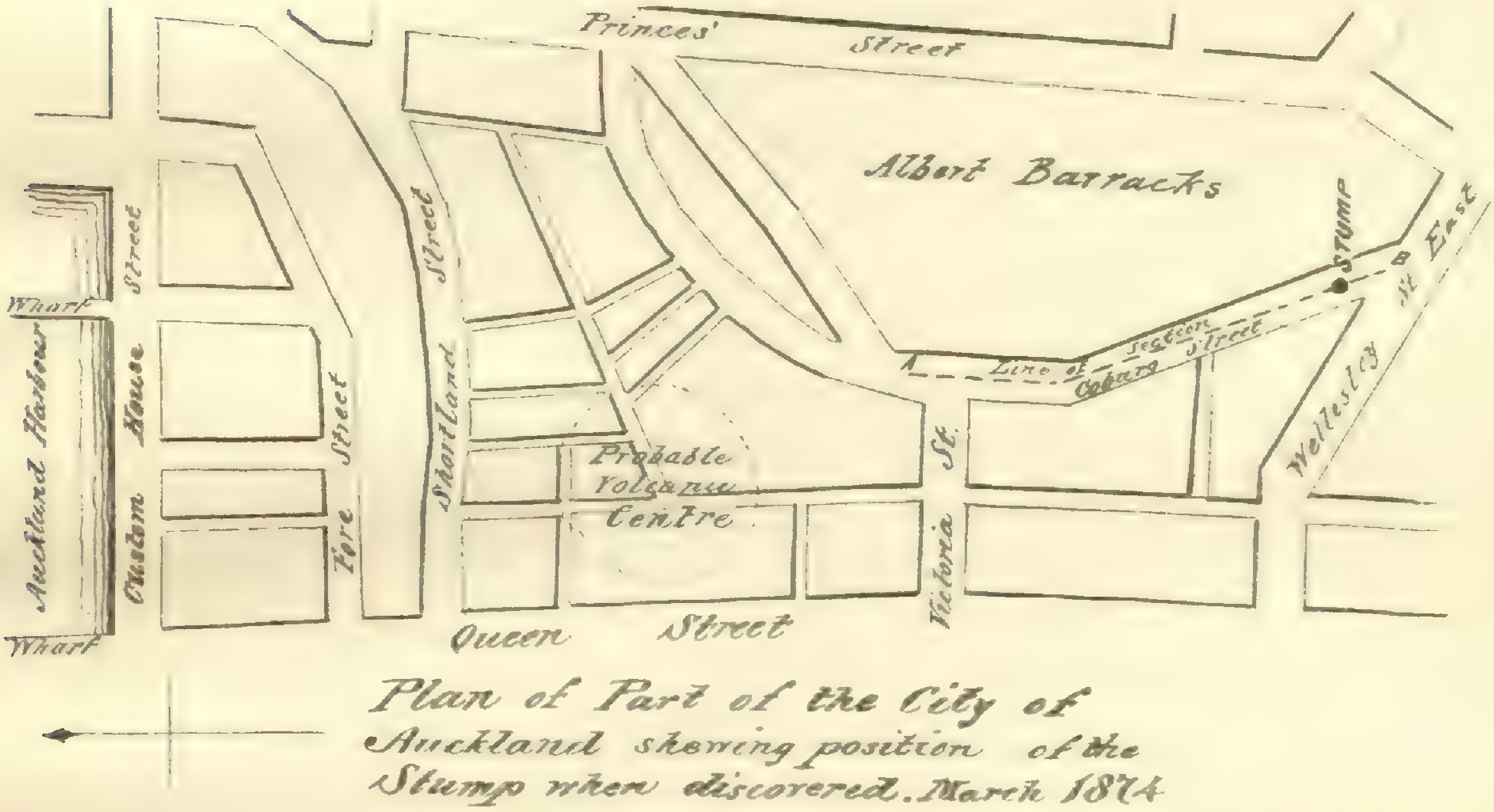
Plate VI.

[Read before the Auckland Institute, 29th June, 1874.]

I have to record this evening a discovery giving a trace of human life on this island, and in this locality, reaching back beyond history, and supporting the Maori tradition that this island was inhabited before their arrival here, and that the Maeros* of the North Island and the Ngatimamaeros* of the South Island, may yet be found to be real aborigines, and not degenerate or wild Maoris, as has been supposed by many. This latter belief has doubtless arisen from want of evidence beyond the faint tradition of the Maoris. Such evidence I have been fortunate enough to obtain, and now submit to this Institute, trusting that the link thus supplied may be the means, in hands more versed than mine in the early history of New Zealand, of deciphering a page of its history, and throw light on a subject that has puzzled many.

Heavy excavations have been carried on at and about the Albert Barracks by the Auckland Improvement Commissioners for the purpose of making new streets for the benefit of the city. During last March, while works were being carried on in Coburg Street, near the junction of Wellesley Street

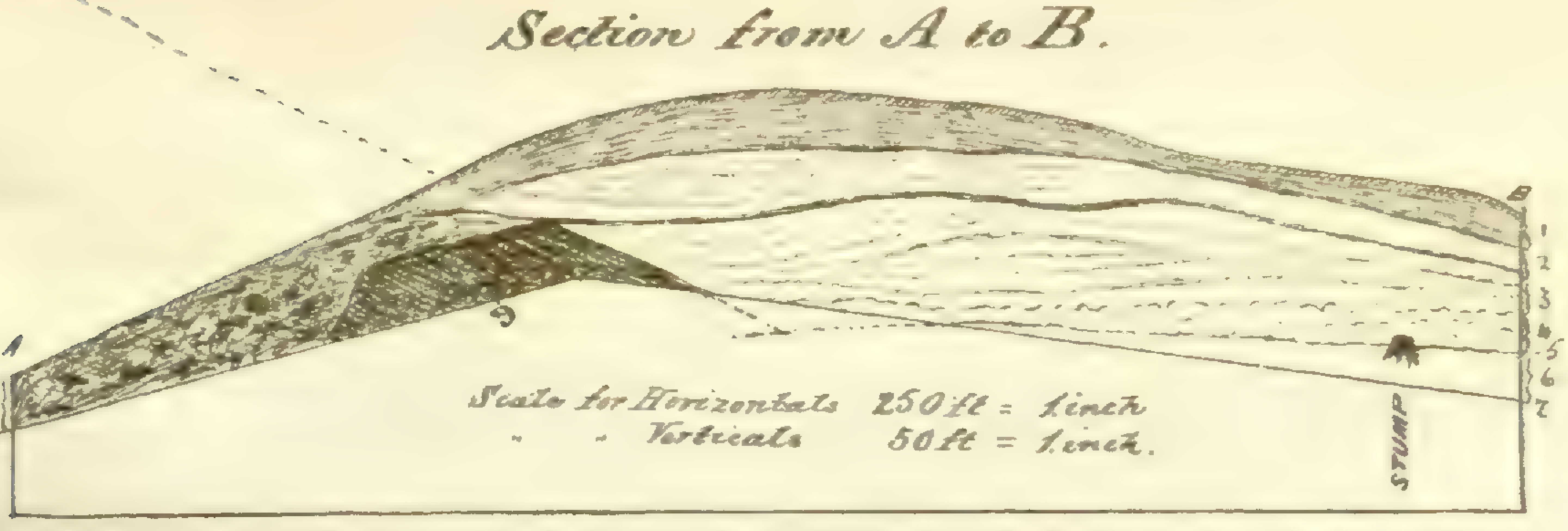
* For an account of Maeros and Ngatimamaeros, see Hochstetter's "New Zealand," page 210.



Plan of Part of the City of Auckland shewing position of the Stump when discovered. March 1874.

Scale for Plan 3½ chains = 1 inch.

Section from A to B.



1. Surface soil and decomposed Volcanic ash
2. Stratified decomposed ash & ooze
3. Stratified ooze containing layers of cinders
4. Stratified ooze, cinders & iron oxide
5. Surface of Tertiary clay containing loam
6. Tertiary Clay
7. Bottom of Sewer cutting
8. Conglomerate of ash & volcanic boulders
9. Layers of cinders, part of old cinder cone.

To illustrate Paper by John Goodall.

East, the workmen came upon the tree stump, now before you (see Pl. VI.), lying in the centre of a narrow channel below the road level, this channel having been cut for the purpose of laying sewer pipes. Through the intelligence of Mr. James Williamson, the contractors overseer, who at once recognised its value, it was saved. Shortly after I was on the spot, and my attention was drawn to it.

It being important that the discovery should be verified by undoubted authority, I immediately went for, and returned accompanied by Theophilus Heale, Esq., Inspector of Surveys, who satisfied himself as to the genuineness of the discovery, and the undisturbed stratification of the volcanic *dêbris* of about 25 feet lying above. The place where the stump was found is shown on plan and section (Pl. VI.). In the section I have shown the stump as when found resting on the clay. It was in its natural position, upright, with its roots penetrating the clay, of which fact I satisfied myself by digging deeply below to a depth of over two feet, and found the traces of roots going down. The surface of the clay has loam in it. The top of the stump was embedded in volcanic mud, and above it there were 25 feet of *dêbris* in perfect stratification, as shown in section. These stratified beds of ooze and *dêbris* can be traced till they reach the beds of cinders, and thence to the conglomerated mass of scoria and basaltic lava, which occurs adjacent to the volcanic centre. The clay in which the stump once grew occurs immediately above the tertiary rocks, and and is from 10 to 15 feet thick. This stump is asserted by those who have a knowledge of New Zealand woods to be of tea-tree (manuka) the wood that has been chiefly used by Maoris for making paddles. It has an undoubted appearance of having been cut by some tool, and being so must have been by the hand of man. I leave it to any one to satisfy themselves by a personal examination whether it be so or not. The cut seems to be too fresh to refer back to so remote a period as the volcanic era, but with the evidence we have of the finest markings of ferns, shells, &c., being preserved from ages vastly more remote, surely we may expect it from this, which in comparison is but recent.

Undoubted as these facts may appear it may yet be well to consider by what other means they may have been produced. The stump may have been lodged where found by a landslip, it may have been burnt off, or it may have belonged to a rotten tree and been broken down by the wind, or by the flow of the volcanic ooze in which it is embedded. That the stump was not lodged there by a landslip may be seen by the section which shows the overlying strata perfectly undisturbed, and it is further evident that it must have grown on the spot where found as its roots were penetrating the lower clay; every where above the clay abundant remains of trees occur and roots in the clay, showing that the place was wooded at the time prior to its being covered by

the volcanic *débris*. That it was not burnt off is certain, from the sharpness of the edges of the surface, the absence of charcoal, or even of a charred appearance, and the presence of a projecting piece of wood in the centre of the stump, which must have held the tree upright to the last, and which would not have existed had it been fired. That it did not result from a rotten tree is equally evident, for it could not now be in so good preservation, the bark would not have remained on it, the sharpness of the edges would not have existed, and the wood would not now be fibrous ; decayed wood would have lost its fibrous structure. It is therefore beyond any doubt that we have evidence of the existence of man long before the period indicated by the traditions of the Maoris of their advent to this island, and at a period before what is probably the oldest volcano in Auckland became extinct. In the Maori traditions there is no mention of any of the volcanos near Auckland having been active.

Art. XIII.—*Description of a Wreck found at the Haast River.* From a Report to his Honour J. A. Bonar, Superintendent. By Thomas Turnbull, Chief Harbour-master of Westland. Communicated by W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 8th August,* 1874.]

I have made all inquiries possible at Hokitika respecting a portion of a vessel brought up from the Haast by the steamer Waipara on the 30th of last month. The position of the original piece is on the N.E. bank of the Tauperikaka River, a small stream discharging itself into the sea, about three miles south of Arnott Point, on the west coast of the South Island. The piece of wreck is about 100 yards from high-water mark, and surrounded with dense bush to the river's edge, showing that it must have been carried into its present position some years ago by the action of the sea.

The first notice of the presence of such a thing as a wreck in the bush was communicated to me during the rush of miners to that locality in the year 1866-67, when it was found by some prospectors who were looking for gold, and rather astonished them. The piece in question was then about 27 feet long and 12 feet deep, and is a portion of the broadside of a large ship of very peculiar construction. I can find no trace of any such vessel having been seen on the coast at the present time. There is a resident at this place who was on the coast as far back as 1839, and I will give his own version of his early knowledge of the West Coast.

He says his name is Thomas Shannon and that he is fifty years of age, and that he sailed from London *viâ* Lisbon in the barque "Speculation," Captain Robinson, on a sealing voyage to Desolation or Kerguelen's Land, but that, owing to the loss of their tender in Saldanha Bay (West Coast of Africa) during the above year, the voyage was abandoned and they proceeded to Sydney and thence to the Bay of Islands. Having refitted they proceeded to the Auckland Islands, and onward above the Antartic circle, where they met with severe weather, and had to return north to the Bluff Harbour to refit. They had been in company far south with Commander D'Urville, as also the American Survey Expedition, under, he thinks, Captain Reller. Leaving the "Speculation" at the Bluff he joined a whaling party at Jacobs River under Captain Howell, and the following season, 1841-42, proceeded to the East Coast of this (the South) island on a sealing expedition in open boats. That season their operations extended as far as the Blue River (three miles north of Arnott Point) sealing, and at the same time looking for a band of natives to chastise (shoot) them for killing and eating the previous season a boat's crew whilst on a sealing voyage from Jacobs River. At that time there were several native pas on the coast between Jackson Bay and the Bruce Bay of the present day, but being at that time cannibals, the Jacobs River Maoris would not hold any intercourse with them.

Nothing was known at that time of any wreck on that part of the coast, nor was there any sign at the Blue River of any wreck, but on their return south, after passing Milford Sound, they came across several portions of cedar logs, showing evidence of fire, or that a vessel had been burnt at sea with a cargo of cedar timber on board. The cargo was strewed on parts of the coast from a little south of Milford Sound up south as far as Windsor Point, S.E. of Preservation Inlet. No portion of any wrecked vessel was seen or heard tell of except one in Facile Harbour (Dusky Sound), the date of the loss of which vessel seems uncertain, as no particulars of her loss were current amongst the oldest hands on the coast, except that she was a teak-built ship, and that portions of the skeletons of her crew were found and buried on Green Island, and supposed to be Lascar sailors from the small stature of the remains found. No name of the vessel, or further information relative to the loss of the vessel was known on the coast.

My informant Shannon is of the opinion that the piece of wreck in question recently brought up to this port is a portion of a Netherlands built vessel, and as to her construction he assures me that during the early time that he was on the coast of New Zealand, since 1839-40, he never heard of or saw any vessel of the same construction as the one about which inquiries have been made. I may state that in 1866-67 there was a portion of a figure-head lying in the bush about seven miles south of where the portion

of the wreck was found, and near to an old camping ground or pa of the Maoris, on the south side of the Maita River, but which was, I have been told, burnt by a party of diggers. The figure-head, I have been told, was a female figure, but much destroyed.

In conclusion I am inclined to think that the vessel of which those pieces once formed a part was not of British build, and the timber certainly indicates to my mind that it was either French or Netherlands, as supposed by Shannon, and I would recommend that a portion be sent to London to Lloyd's rooms for inspection.

The vessel seems to have been built altogether of a number of thicknesses of planks, placed in the following order:—

1st, or outside, horizontal, Baltic oak.

2nd, perpendicular, Baltic pine.

3rd and 4th, diagonal, Baltic pine.

5th, perpendicular, Baltic pine.

6th, inside, horizontal, Baltic oak—with a material resembling felt between the first four thicknesses from the outside, and all securely fastened with metal and iron bolts, and further fastened with screw-treenails of some hard dark brown wood. I have formed my opinion as to which is the outside and the inside from the formation of the screw-treenails, always supposing that they would be put in from the outside of the vessel, and the felt or other substance being also on that side of the pieces which I suppose the outside.

Art. XIV.—*Notes on the reported Collision of Biela's Comet with the Earth's Atmosphere.* By Henry Skey.

[*Read before the Otago Institute, 11th June,* 1874.]

With reference to a paper read before this Institute on 12th March, 1872, on the zodiacal light,* in which a theory is advanced tending to show that the periodic November meteors form part of that illuminated medium, thus forming a probable clue as to the real direction of solar motion in space, it will, I think, be interesting to review the published results which followed the actual collision of Biela's comet with the earth's atmosphere on the 27th of November following, and which confirms in a remarkable manner the hypothesis set forth in that paper of the action which would result from the collision of meteoric vapours with the earth's atmosphere; for it is now generally conceded that to Biela's comet is due the magnificent display of shooting-stars which, on the night of the 27th November, 1872, streamed into our terrestrial atmosphere.

* Trans. N.Z. Inst., V., app. p. lxiii.

This collision may, I think, be fairly considered to be one of the most remarkable astronomical occurrences of modern times, and appears to invalidate the generally received opinion as to the solidity of the matter of meteors, and consequently induces us to question the correctness of what is known as the "Meteoric Theory of the Sun," which assumes the sun's light and heat as being sustained by its surface being bombarded by myriads of solid meteors, and the zodiacal light has been conjectured as being an illuminated shower, or rather tornado of stones, which are to furnish their equivalents of heat and light by the sudden check to their motion when they fall into it.

Now comets are known to be bodies of almost inconceivable tenuity, as proved by the immense perturbations they undergo by the attraction of the planets, without being able to induce any appreciable effect themselves on the orbits of the planets, or even of their satellites. Another proof of their tenuity is the fact of their not being well seen in telescopes of high magnifying power, and it is highly probable that a comet, when very close to the earth, cannot be seen at all by its ordinary illumination, for its light would be so much diffused, and subtend so large an angle, that its illumination would fail to be detected.

Immediately after the meteoric display alluded to it occurred to Klinkerfues to suggest to the Madras astronomer a search of the heavens near *theta Centauri*, or in direction diametrically opposite to the radiant point of the meteors (*gamma Andromedæ*) for the missing comet, and a cometic-looking object was actually noted by him, but not sufficiently near to that point to render it demonstrable that the object he saw was the truant comet or any part thereof. When, however, we consider the enormous perturbation the comet must have undergone by its proximity to the earth probably that difficulty might vanish. It has been calculated that the meteor stream of the 27th November was nearly twelve weeks behind the head of the comet. Now we can scarcely suppose that any detached collection of solids should be dragged after a comet, such would surely be contrary to all analogy. The conclusion presents itself that if a comet is so drawn out, either by the perturbations of the planets, or by a resisting medium, the parts so drawn out would be of greater tenuity than the comet itself.

We may, therefore, fairly infer that matter in a non-solid or vapourous form, when coming into collision with the earth's atmosphere at orbital velocities is competent to produce all the phenomena known as shooting stars and meteors.

At a future meeting I shall be prepared to give another paper embodying a series of actual observations "On the direction—the arc subtended—and times of visibility of the Zodiacal Light," made since 1872, tending to confirm the theory that this medium has points of greatest elongation in a line coinciding with that of the sun's motion in space.

Art. XV.—*On the Zodiacal Light, as seen in Southern Latitudes.* By Henry Skey.

[Read before the Otago Institute, 14th September, 1874.]

Not only has the science of astronomy received a most remarkable impetus by the use of the spectroscope, but that of meteorology has been extended likewise, so that from treating only of mundane or terrestrial results—as the weather—it now claims within its domain the magnificent phenomena of solar atmospheric action, the physical formation of stars, comets, and meteors, and even to the bounds of the known universe it ascertains without a doubt the gaseous constitution of some of those distant nebulæ and the remarkable changes which they undergo.

Intimately connected with these subjects may be considered the investigations on the nature of the zodiacal light. In a previous paper* on this subject a theory was advanced in which the elongation of the medium of this remarkable illumination was attributed to the action of an interstellar and resisting medium upon the heat-repelled constituents of the solar atmosphere, thus causing a portion thereof to drift in rear of the sun's proper motion, whereby it would cease to retain the diurnal rotation and tend towards an orbital motion; and the times of visibility of this light in the northern hemisphere, as given by Herschel, were adduced as leading to the conclusion that in the month of November the earth must pass near if not actually through it annually, the November meteors being instanced as the result of the collision. A diagram was also given† explaining its appearance as seen from the northern hemisphere.

In November, 1872, Mr. Webb gave an interesting account of the most recent observations on this light,‡ stating that it was visible in some parts of the earth nearly all the year round. The accounts therein given do not, however, furnish us with the amount of elongation, nor mention whether that elongation is constant, nor yet inform us whether it is visible in the mornings and evenings of the same day, and the time of year that it is invisible; and as these data are necessary in order to ascertain the true shape of the zodiacal envelope I therefore commenced tabulating what could be observed on these points in our southern latitude from 1872, the results of which are appended:—

1872, July 2nd—An illumination along the ecliptic was observed in the western part of the sky at 7.30 p.m. It was nearly as bright as all but the brightest portion of the Milky Way, which was also very brilliantly shining. The air was very transparent and the hygrometer showed saturation. The

* Trans. N.Z. Inst, Vol. V., App. p. xliii. † Vol. V., pl. XIV. ‡ Vol. V., App. p. xlvii.

light subtended an arc of 40° from the base to the vertex. It was also seen on the 5th after twilight and on the 26th, at 7.30, it subtended an arc of 45°.

August 1st—It was very clearly visible at 8 p.m., subtending an arc of nearly 60°; also on the 26th, when the air was so transparent that small stars could be seen very near to the horizon. The length of arc being about 45°.

September 1st—It was also observed. The angle subtended is less, but the vertex now reaches nearly to the Milky Way; also on the 19th and very distinctly on the 27th, its vertex now reaches the Milky Way in the constellation *Scorpio.*

October 2nd, 4th, 5th, and 21st, the same light was visible for a short time after sunset, but its vertex soon sets at this season and ceases to be seen in the evenings. This light was never seen in the mornings before twilight and sunrise in any of the preceding months, although looked for under favourable circumstances, but it begins to be faintly seen in the mornings in the beginning of March, and on the 31st it was very distinct, extending along the ecliptic, subtending an arc of 30° at 3 a.m., and of 45° at 4 a.m., reaching nearly to the Milky Way and pointing to *Antares.* During April and May it is still seen, but in June it becomes so faint as to be doubtful. It began to be faintly seen, however, in the western sky at the end of June in the ecliptic pointing and extending near to *Spica Virginis* and was seen every favourable evening in July reaching to *Spica Virginis.* In August it extended beyond that star reaching nearly to *Antares*, subtending on the 23rd an arc of 50° at 8.30 p.m. In September it had the same appearance as in 1872, extending to *Antares.*

During the years 1873 and 1874 it also presented the same appearance at those times.

A summary of these observations shows that in S. Lat. 46° this illumination begins to be visible in the evenings after twilight, and when the moon is absent at the end of June; early in August it attains its greatest elongation and brightness, forming quite a feature in celestial scenery; it then gradually decreases till the end of October, when it ceases to appear in the evenings, but can be seen in the mornings in March, April, and May, and very faintly in June. Its inclination to the plane of the ecliptic appears to be nearly four degrees, the advancing cone seen in this latitude lying on the south side of the ecliptic.

It always points towards the same constellation, *Scorpio*, whether seen in mornings or evenings, showing that it is that part only of the zodiacal envelope which is on one side of the solar orb which can be seen in this latitude, and that that part is in advance of the solar motion in space.

The colour of the illumination as seen in south latitude is invariably clear

white, while the colour of that part of the envelope seen in north latitude, and which is in the rear of the sun's motion pointing towards the constellation *Taurus*, if projected on the ecliptic, is said to be a characteristic rose-red. This indicates a difference of constitution suggesting a spectroscopic examination.

The vertex of this light appears to be projected by parallax on different parts of the ecliptic by the earth's motion in its orbit, thus appearing to prove that its shape is elongated, and not circular, for if circular, then it would subtend a similar arc all the year round.

It regularly decreases in altitude in the evenings by an amount corresponding to the angular motion of the earth on its axis, and when seen in the mornings it increases in the same ratio, from the first appearance of the apex above the horizon to such a time as it ceases to be seen from its delicate illumination being overpowered by the solar glare, which fact appears quite sufficient to prove its extra-terrestrial origin.

From the constancy of its appearance at the above seasons it does not appear to be of an intermittent nature, such as we might expect if produced electrically, or if it was of a similar nature to our auroras.

Observations on zodiacal light, comets, and meteors, are fraught with renewed interest now that such stupendous commotions are known to occur near the sun's surface, especially after the connection apparently established between the highly attenuated material of Biela's comet with the meteoric display of 27th November, 1872; and it is to the meteorological changes of matter in the sun's neighbourhood through all its possible states from gaseous to vapourous—liquid and solid, and again from solid to liquid—vapourous and gaseous, that we may probably look as furnishing a clue to one of the most important problems in modern physics, namely, explaining the action of those laws of attraction to a centre, and of heat repulsion from a centre, which appears to characterise all cosmical aggregations of matter.

Art. XVI.—*On a new Thermometer for Lecture Purposes.* By A. W. Bickerton, F.C.S., Professor of Chemistry in Canterbury College.

(With an Illustration.)

[*Read before the Philosophical Institute of Canterbury, 1st October*, 1874.]

A thermometer of simple construction that would show variations of temperature to a large number of persons at once, would be very useful in the lectures on heat and kindred subjects. It would be of especial value in schools, where but little time can be spent in preparing experiments. A thermoelectric pile and galvanometer is a most valuable piece of apparatus,

but there are many cases to which it does not apply well, nor is it well seen in flat rooms, in which most elementary teaching is carried on; it is also expensive, and requires some skill to use satisfactorily. These considerations, and the necessity I have often felt for such an instrument, induced me to design the thermometer described below. The thermometer depends upon the different coefficients of expansion of metals, and is constructed as follows:—

About a dozen pairs of thin strips of zinc and steel, about 4 inches long, are riveted at their alternate ends, the two outside strips are continued on beyond one end of the bundle so formed. Each of these two pieces have a steel pin soldered across its end; these two pins work in holes in the end of a long index finger, which at the mean temperature of the range of the thermometer is in a straight line with the bundle of metal strips. Any increase of temperature causes each of the zinc strips to expand more than the steel, and the sum of their difference is at once transmitted to the pins, one of which is thus thrust beyond the other, and so causes the index to move on one side. When the temperature is lowered the index moves to the opposite side. The bundle of strips is filed up into a cylinder and placed in a copper tube, the bottom of which is closed. At the top of the tube is fixed a fan-shaped piece of metal, on which is marked the scale of temperature. The index moves backwards and forwards in front of this scale. The accompanying sketch shows the construction of the thermometer.

When the thermometer is used before a large audience the size of the scale may be increased by fixing to the back of the permanent scale a quadrant of black paper having white figures on its circumference. The metal index may also be lengthened by a strip of white paper pasted on it. With these additions the movement of the index produced by an alteration of a few degrees of heat may easily be seen by an audience of any number. I have used the thermometer to illustrate the following facts:—1st. It offers a good means of showing, by the principle of its construction, the difference of expansion of different metals. 2nd. The constant temperature of fusion and boiling. Thus the thermometer is placed in ice at $-10°$ C., heat is applied, the index moves up to zero, it then remains still till all the ice is melted, it then goes on moving up to $100°$ C. 3rd. A pair shows well the different rate of cooling of water in polished and blackened tin tubes. 4th. The cold produced by the fusion of solids on ordinary freezing mixtures. 5th. The cold produced by evaporation, and of course a pair would show the difference of wet and dry bulb thermometers.

It might also be used to show the heat developed by friction by placing it

in a block of wood made to revolve rapidly. It would also do well to show the constant boiling point of the different compounds in a substance subjected to fractional distillation, and for many other experiments. Mr. Ward, of the School of Mines, has suggested that it would be useful for fractional distillation at high temperatures, for which the mercurial thermometer is not available. I have had a thermometer made with brass instead of zinc for the purpose of making experiments extending over some time in order to ascertain if the instrument is reliable for purposes of observation at comparatively high temperatures. When the thermometer is required to be sensitive to a very small alteration of temperature I have used two such bundles side by side; these two bundles are connected together by a diagonal piece of steel from the top of one bundle to the bottom of the other. The two pieces supporting the pins are brought up together, one from each of the other ends of the bundle of strips. I may mention to any one wanting such thermometers that Mr. Ladd, London, and Mr. Noble, Christchurch, have made them, and are consequently conversant with their construction. The dotted lines on the cut represent zinc, and the continuous ones near them steel.

Art. XVII.—*A Scheme of University and General Education.* By A. W. Bickerton, F.C.S., Associate, Royal School of Mines and Professor of Chemistry in Canterbury College.

[*Read before the Philosophical Institute of Canterbury, 28th October*, 1874.]

It is now a well established fact that from economical motives alone it is a profitable investment for a country to give a fair education to its inhabitants. It is even believed by many that the education of all might profitably be extended considerably beyond what is now called "elementary education." When a boy enters a workshop or an office his time for being regularly taught has generally passed. All he meets with are too busily engaged otherwise to give him any careful instruction. What he has now to do is to keep his eyes open and learn for himself. It is frequently the case that with badly trained reasoning powers he learns only by "rule of thumb," and there are but few could give reasons for what they do. The result of this is, that disastrous failures constantly occur when something has to be done out of the "regular groove." The heaps of spoilt materials, often of splendid workmanship, which are to be found in almost all old workshops, are monuments of this wasteful ignorance. It is scarcely possible to conceive the amount of time lost and the number of valuable lives wasted in attempting things which a slight knowledge of natural laws would have demonstrated to be impossible. Perpetual-motion engines, fly-wheels to increase the sum of work from a uniform

machine, lifting-pumps that would require double the pressure of the air to work them, and such like, are illustrations of what are constantly made by thousands of the ablest of our skilful and ingenious, but uneducated, mechanics. It should, therefore, be the duty of the State to see that every child has a sufficient education.

That this may be done satisfactorily, all elementary schools should be free, and the attendance at some school compulsory. As the prosperity of their children is one of the chief objects of many men's labours, it is not to be desired that the children of the industrious and frugal should be no better off than the children of the idle and thriftless. We must expect that the sins of the parents will more or less be visited upon the children; nevertheless, these unfortunates should not be allowed to go utterly to ruin. The gift of a fair education is one that may safely be given to all, without diminishing the incentive to work which a parent feels on behalf of his children's material prosperity. There can be no doubt that a child will be much less likely to add to our criminal population if the portion of his life when he is most susceptible to various impressions be spent in the school rather than in the streets. Therefore both from motives of humanity and economy every child should have an education sufficient to train his moral nature to a just appreciation of right and wrong; his reasoning powers to be able to form a sound judgment; his power of observation should be cultivated, that the teeming wealth of nature may not be wholly lost to him; his eye, also, should be trained to accuracy and beauty of form, and his hand to be the ready and faithful servant of the mind and eye. He should also be taught something of the properties and laws of the various forms of matter with which he is surrounded. To do this would require a considerable outlay; and here, by way of parenthesis, allow me to indicate how I would obtain the means necessary for a general scheme of education.

In a new country it seems to me that the best way of providing for the expense of education is by reserves of land; for, as the number of the inhabitants increases, so will the rent of the land, and the increased expenditure will be thus met. If the reserves of any particular district be at any time insufficient to provide for the fixed minimum of education the State should subsidise out of revenues. But that the amount obtainable from the reserves should be a matter of local interest, a tax of one-third the Government subsidy should be levied on the inhabitants of the district; and in those places where the reserves are more than sufficient, this sum should go towards increasing the higher educational appliances of the district. I consider a complete system of education should consist of the following:—Infant schools, elementary schools, advanced schools, colleges, and examining body (the University), and training college for masters.

Infant Schools.

It is a difficult task for mothers to interest children when attending to their domestic duties. Infant schools are of great value as a relief to mothers, and to give variety to a child's life, their object should be principally to amuse and interest in a rational manner, rather than to instruct; all lessons should be very short, and should be directed rather to a child's memory than to its reason.

Elementary Schools.

These should be as large as possible, and should, therefore, be so situated as to command a large district. Considerable space should be allotted for recreation. The schools should be large, in order than an efficient staff of masters may be kept, and that the children may be divided into classes large enough to have a separate master, and use a separate room. It is most difficult to keep the attention of a number of boys if several teachers are at work giving instructions before various black-boards in different parts of the room. I can testify to the extremely hard work it is to the teacher, as I have on several occasions given lessons to advanced pupils in the same room in which several elementary classes were being taught, and have found that the strained attention required for discipline makes spirited teaching an impossibility. I look upon separate class-rooms as absolutely essential to the fair progress of the pupils.

The question of "mixed schools" (that is where both sexes are taught together) is receiving great attention in England; it is a question upon which I can offer no opinion. I know, however, it is believed in by many holding the very highest scholastic positions in England, and it is worthy of careful investigation.

I am of opinion that the subjects taught to all the pupils of elementary schools should be of a much wider range than at present. There should also be additional subjects, which should be paid for if parents desire their children to learn them. After "the three R's," the next most important thing, in my opinion, is mechanical drawing. This at present is scarcely taught at all, yet it is not too much to say that in many trades it is almost more important to be able to read a drawing than a book, and to make one than to write. There are but few professions in which a knowledge of drawing, particularly mechanical drawing, would not be useful. The use of mechanical drawing instruments is a fine means of giving a careful delicate touch and manipulative faculty. It is, I believe, altogether the best means that can be used for this purpose in large classes. I am convinced also that as a means of intellectual training the problems of mechanical drawing are of immense value. The importance of mechanical drawing has been very rapidly forcing itself upon the minds of all engaged in education, especially is this the case wherever traditional methods

have not acted as a bar to progress. In Prussia at present fully one-third the time in elementary schools is spent in drawing, principally by the use of instruments. Professor Fleming Jenkins, in his presidential address to the mechanical section of the British Association, 1871, devoted more than half his speech to its importance. He thus defines it :—"It is the art of representing an object so accurately that a skilled workman, upon inspecting the drawing, shall be able to make the object of exactly the materials and dimensions, without any further verbal or written instructions from the designer." He goes on to say :—"This kind of drawing educates the hand and mind in accuracy, it teaches the students the elements of mensuration and geometry, and it affords considerable scope for taste where taste exists." I have too much to say on other topics to dwell further on this subject, which would require a whole evening to say all that its importance deserves. The study of mechanical drawing should be commenced in the elementary schools by practical geometry, then proceed to making plans and elevations of simple solids and the construction and use of drawing-scales.

The other subjects for elementary schools should be—Freehand drawing, as far as copying simple curves and models; arithmetic, including decimals; algebra to equations; as much theoretical geometry as the first book of Euclid (it is, however, the opinion of some of our ablest geometricians that Euclid is not the best teacher); mensuration of surfaces; as much chemistry as to understand the simple processes of nature; the elementary parts of heat, light and electricity; human physiology and the elementary principles of hygiene; some science of observation—as geology, botany, or some branch of zoology; a slight knowledge of the geography of the world, and a little more of his own country; English grammar to the rules of syntax, and about 1,000 roots of the English language; gymnastics, drill, and vocal music. The following are the additional subjects that might be taught on payment in elementary schools according to the demand of the neighbourhood; I do not, however, consider that these subjects should wholly depend for their support upon the fees charged :—Elements of French or German, Latin, history, music (instrumental), colouring (water-colour drawings), political economy.

Advanced Schools.

The attendance at these schools should not be compulsory nor free. The fee charged should not be large for the general curriculum of the school, but additional fees might be charged for extra subjects. In order to prevent these schools from becoming mere elementary schools for the wealthier classes the pupils should pass an entrance examination, showing at least the minimum of knowledge of boys leaving the elementary schools. The ordinary course of these schools should be as follows :—Making finished mechanical drawings, projection descriptive solid geometry; freehand drawings; algebra to

binomial theorem; practical plane trigonometry; logarithms; mensuration; theoretical geometry, as much as the first six books of Euclid; elementary chemistry and physics; physiology; geology, botany or zoology; English language; one other modern language; Latin. Additional subjects:—Landscape drawing and painting; second modern language; laboratory work in science; Greek; instrumental music, and history. In connection with these advanced schools there should be evening classes, that the pupils who have passed through the elementary schools and whose parents did not send them to the advanced school, and others desirous of doing so, might have an opportunity of continuing their studies. The pupils attending these classes should pay about one penny per hour; the payment should be quarterly, thus one shilling per quarter for one hour per week. The teachers in these classes should also be paid by Government on the result of examination of the pupils once a year.

Colleges.

As the advanced schools would be small in number compared to the elementary schools, so the colleges would be small in number compared to the advanced schools; one for each province seems quite sufficient at present, and will probably be so for many years. The colleges should either have a museum of their own, or should be attached to existing museums. It would be desirable to be near a hospital. It should stand in grounds of not less than 100 acres, if possible. The permanent success of a higher educational establishment very much depends upon the *esprit de corps* existing among the students, and nothing more conduces to develope this than good recreation grounds for cricket and other out-door games. Proximity to a river, that boating and swimming may be practised, would also be of value for the same reason. College friendships (which give such pleasant associations to our days of study) are more frequently developed in the hours of recreation than the hours devoted to study, and there is an incompleteness about educational establishments where the students meet only during the hours of study, which is very striking to any one who has been associated with institutions of both kinds. The colleges should be for persons over fifteen years of age. The students should be of two classes, namely, those attending only certain classes, and those entering for a complete course. The complete course of instruction in the college should be arranged in a time-table extending over three years. Except in special subjects the first class of each course would commence each year, and first year, second year, and third year classes would proceed simultaneously. Care should be taken in arranging this table that the classes of each year's students do not clash. The course of lectures should, in all cases, be thorough, and extend to the present bounds of knowledge. The regular college hours should be from ten to one and from two to five, with ten to one

only on Wednesdays and Saturdays. The fees payable should be 10s per term for one hour per week and so on. A special fee might be charged to students entering for a complete course, say £8 to £10 per term. There should be evening classes in the various subjects taught by the lecturers and professors. These classes should not be so complete as the day classes. The broader principles and more important generalizations should be well worked, with the view to give the students a comprehensive grasp of the entire subject, while the smaller details might be left for private study. Each professor should give one hour per week each term; the lecturers one hour per week for one or two terms. The fee might be about 2s 6d. At the discretion of the Board of Governors this regular course might be replaced by a course of popular lectures, to which course no greater sum than 2s 6d each person may be charged. The regular course of instruction in the colleges should include a complete course of all the sciences—Mathematics, drawing, modern languages, classics, mental philosophy, history. Special courses should also be established for the professions of law, medicine, and engineering.

The University.

This would consist of an examining body, with a power of conferring degrees and granting scholarships, fellowships, etc. That a degree given by a university may be valued, the examinations upon which it depends must be of a high class. The worth of what is to be obtained, and not the mere facility of obtaining it, is the incentive to work with most competitors. The success of the London University offers a good example of this fact. In looking over the New Zealand University Calendar any one having the smallest knowledge of science cannot fail to be struck by the absurd simplicity of the science examination papers. The classical subjects would require years of careful training to pass successfully, whereas I am convinced that as much science as would pass the examination in any of these subjects might be taught in a few days. This should not be so; a fair knowledge of chemistry requires quite as much study as a fair knowledge of Greek, and yet the questions in chemistry require about as much knowledge of the subject as would be required of Greek to master the alphabet. No doubt the study of science at the present time requires to be fostered; but this should be done by providing good teachers and proper appliances for teaching, and by giving scholarships and fellowships of value to successful students, rather than by making the examinations so ridiculously simple that the knowledge required to pass can scarcely be of any value to the holder. Let science once be well known and properly taught it will require no further bolstering up; its own intrinsic merits will be a sufficient inducement for its study. The examiners should be men practically acquainted with the subject; no one should examine in more than two subjects, and there should be some especial reason for his taking more than

one. The examiners in every subject should be changed every two years, one-half each year, otherwise competitors get to know the examiner's specialities, and learn to meet them rather than take a comprehensive view of the whole subject. All advanced examinations in science should include practical work. Thus, in chemistry, certain mixtures for analysis should be sent to all the examining centres. In mineralogy large minerals should be broken up into sets; the sets numbered alike, and one sent to each place. The specimens of geology, zoology, and the other natural history subjects should be identified and described. By giving practical work, and by constantly changing the examiners, the injurious system of learning parrot-like answers to certain stock questions would be avoided.

Subjects of Examination for Matriculation.

Mathematics: arithmetic, algebra, geometry, trigonometry, mensuration—four of these to be taken. Science: chemistry, physics, mechanics, geology, physical geography, botany, zoology, animal physiology—three of these to be taken. Drawing: freehand and model, geometry and perspective, mechanical drawing—two of these. Language: English, French, German, Latin—English and two others to be taken.

There would thus be nineteen subjects of examination, of which one competitor may take only twelve. I propose, in order to pass, he should obtain 40 per cent. of the total marks of the twelve subjects, and satisfy the examiners in at least eleven subjects.

B.A. and B.Sc. Many of the subjects of examination should be in common to both, such as:—English, drawing, mathematics, two sciences, modern language. For B.A. in addition: Latin, mental philosophy, history, Greek, or an additional modern language. For B.Sc., in addition to the work common to both: two additional sciences, a good practical acquaintance with one, descriptive geometry, or water-colour drawings, a certain amount of aptitude in the use of tools. For M.A. and D.Sc. the system and subjects of the London University would probably be suitable.

Examination of Schools, etc.

One quarterly examination of elementary and advanced schools, and terminal examination of colleges, in each case conducted by the teachers themselves. Two annual examinations by inspectors of all the junior boys of both elementary and advanced schools. Three annual examinations of all the senior boys of the elementary schools. These latter examinations should be by the same printed papers all over the colony; they should be superintended by the school committees, and the papers examined by assistant examiners, approved by the University examiner of the same subject, who should himself set the papers and examine for medals. 4. A similar examination of the advanced

schools. These two examinations should be open to all boys of the State schools, free, and should be open to others on payment of one shilling for each elementary subject, and two shillings for each advanced. These fees should be returned to all pupils obtaining 40 per cent. of the marks of the examination.

Scholarships, etc., etc.

1. Special subject elementary scholarships.—In the elementary schools there are the regular subjects, and the paid subjects. There should be scholarships awarded on the result of the master's quarterly examination in the ordinary subjects, entitling the holders to attend the extra subjects free. The following three exhibitions and scholarships would be awarded on the result of the annual senior elementary examinations, and be held for three years. 2. Local elementary exhibitions.—1 per cent. of the boys attending an elementary school should have an exhibition entitling them to free admission to the ordinary subjects of the advanced schools. 3. Colonial elementary exhibitions.—1 per cent. of all the boys attending elementary schools in the colony to receive an exhibition entitling them to free admission to the ordinary subjects of the advanced schools, with a small subsistence stipend. 4. Advanced colonial scholarships.—Scholarships to the number of 3 per cent. of the boys attending advanced schools, entitling their holders to free admission to the ordinary and extra subjects of the advanced school, and to a prize of books. A similar system of exhibitions, etc., should exist in the advanced schools for the extra subjects, and for giving admission to the college classes, and should be called respectively :—5. Special subject advanced scholarships. 6. Local advanced exhibitions. 7. Colonial advanced exhibitions. 8. Colonial college scholarships. The three latter would be given as the result of the senior advanced examinations. The special scholarships, Nos. 1 and 5, and the local exhibitions, 2 and 6, would be held only by boys of the individual schools to which the scholarships, etc., were allotted. The colonial exhibitions, Nos. 3 and 7, would be open to all boys attending State schools, and would be awarded on merit only, without giving preference to any individual schools. The colonial scholarships Nos. 4, and 8, will be open to all competitors; the first under thirteen, and the latter under fifteen years of age. 9. At the matriculation examination of the university there should be scholarships called university scholarships. The special subject scholarships, 1 and 5, may be held at the same time as an exhibition, etc., but one only of Nos. 2, 3, 4, 6, 7, 8, and 9, could be held by a boy at once. In the examinations the first boys on the list to the number of scholarships given would be allotted colonial scholarships. These would hold the highest status. The next boys on the list attending State schools only would be awarded the colonial exhibitions. Then, after these, the first boys in each individual school, not included in the above, would have the local exhibitions. Thus, in any school, the colonial scholar-

ships and exhibitions which might be taken would be limited only by the total numbers, and depend entirely on colonial competition, but the local exhibitions would be only held by the boys of the individual school, so that local exhibitions would provoke competition among the boys of the school, the colonial exhibitions among State schools, and the colonial scholarships would be State schools against each other, and against private and other schools. In these examinations less than 40 per cent. in any subject should be considered a failure in that subject, and the marks should not count. 10. University fellowships: the competitors who stand highest in the University examinations for B.A. and B.Sc. should have fellowships to enable them to assist professors in original research, or to undertake research themselves. The fellows should be allowed to choose the college they would attend. They should hold the fellowships only on the condition of being at the college during its regular hours, or being engaged on some investigation elsewhere, with the knowledge of the Board of Governors. The fellowships should not depend upon the holders being or remaining single. They should be granted for two years, and should be renewed if the work done by the fellow was of a valuable kind. It would further be desirable to have some provision made whereby all original work done by the professors, lecturers, fellows, or students of a college might be published in a quarto volume with the necessary illustrative engravings. Those engaged in original research, together with the chairman of the college, should form a committee of publication. If the papers were of a valuable kind the transactions could be exchanged for the transactions of other learned societies. This would be of immense value to original workers.

Prize Medals, etc.

1. Local prizes given by persons in the neighbourhood, or out of the individual school funds, to be given on the result of the master's quarterly examinations. 2. Small Government prizes should be given on the result of the inspector's examination of the junior boys. 3. In the senior examinations of both elementary and advanced schools there should be prizes awarded on absolute knowledge, and medals awarded on both comparative and absolute knowledge. In each subject of examination every boy who obtains 90 per cent. of marks should have first-class prizes, 75 per cent. second class, 60 per cent. third class, 40 per cent. should pass a boy without a prize. Provided the examiner considers that a sufficient standard is reached the first boy in each subject should have a gold medal, the two next boys silver medals, and the three next boys bronze medals. The examinations upon which the scholarships and exhibitions were awarded would be only intended for the boys whom the master considered competent to pass into the higher schools or colleges. The masters should be paid capitation fees upon all successful students, but a small fee sufficient to cover the expenses of the examination

should be first deducted in the case of all failures. These exhibitions, scholarships, prizes, and medals, and the capitation grant to masters, would keep up a constant interest in their work, both on the part of masters and pupils. As the awards are made on both comparative and absolute knowledge, both the state of the education in the entire colony and where the work was best being done would be accurately known. It is obvious that what applies to the colony would apply equally to the province or district.

Training Colleges for Masters.

The system at present used in England to get a supply of teachers is by giving a free education to intending masters on their passing an elementary examination. I am doubtful of the advantages of this almost indiscriminate free teaching and giving small salaries afterwards. It has a tendency to lower the social status of the masters. Persons who can afford to give their children a good education seldom make them teachers of state schools, and men of great ability and energy among the masters themselves look to obtain appointments outside their profession, rather than accept the small salaries generally given. I consider that teachers should be well paid and that as an additional inducement to exertion, as well as from their suitability to the posts, such appointments as school inspectors and examiners should generally be made from among the more successful teachers, whose qualifications fit them for the office. The especial object of the training colleges should be to teach the methods of teaching; of keeping registers, and general school discipline. They should be free to all who have passed such examinations as would prove their knowledge to be sufficient to fit them for the post of masters. The general education of teachers should be at their own cost, or by the system of scholarships above referred to. No one should be permitted to be head master of an advanced school who has not a degree from the University of New Zealand or some other in which the examinations were of an equally high standard. All masters in any special subject in advanced schools should have passed the examination of the B.A. or B.Sc. in that subject.

Payment of Teachers.

Money prizes, accompanied by certificates, should be given to the first, say thirty, elementary masters, and the first ten advanced masters as tested by the pupils' examinations. The other payment of masters should be, first, by fixed salary; second, ratio of school fees; third, payment on result of examinations.

Inspectors of Schools.

Inspectors should be appointed to visit schools, to see to the keeping of registers; to examine the junior boys, to look after the discipline, cleanliness and style of speech of the scholars; to see to the state of the school buildings,

furniture, and teaching appliances. Each inspector should visit the whole of the schools of the province in succession, and by this method, as different inspectors would visit the schools, one would be a check upon the other, and the probability of the work being well done would be greater.

The system I have thus sketched out would give a constant incentive to exertion on the part of all concerned; would give every child a fair education; all who choose to pay for it a good education, and by the system of exhibitions, etc., would enable the poorest boy to obtain the highest educational advantages if he was possessed of industry and capacity.

ART. XVIII.—*On University Education.* By the Rev. C. FRAZER, M.A.

[*Read before the Philosophical Institute of Canterbury, 26th November,* 1874.]

ATTENTION has recently been drawn to the subject of university education in connection with a complete general scheme sketched out by Professor Bickerton. I wish to take advantage of this opportunity to discuss one point in university education, as to the course of instruction to be pursued. Whatever other effect it may have this paper may at least be useful in drawing forth the opinions of others, and in preparing for a good understanding between the Colonial University and the colleges connected with it.

One difficulty seems to present itself consequent upon the liberty of choice now given to students as to the branches they shall study, and upon their proficiency in which they may obtain a degree. It becomes requisite, in these circumstances, to determine the length of time to be devoted to each subject, and the value to be attached to it in an examination for honours.

The proposal has been made, and has met with general approval, that the degree of Bachelor of Arts or Science should be so granted as to be a guarantee that the holder had attended a full course of college study, and had made good progress in his studies; while the degree of Master of Arts or Science should be an honourable distinction, marking considerable attainments, and might be awarded in two grades, M.A. simply, and M.A. with special honours.

It seems further to be agreed upon that the college course should extend over three years; but that students might have the option of protracting it over four or even five years, provided they attended the requisite number of classes, and stood the final examinations. Such a modification would be of great advantage to teachers and others, who, while engaged in needful avocations, desired to prosecute their studies to good purpose.

The length of time devoted to each particular subject, and the prominency

to be attached to it in a general examination for degrees, afford occasion for considerable differences of opinion; for, naturally, every man will be inclined to estimate highly the special branch which most engages his own attention or is most congenial to his mind. The question as to the comparative claims of the ancient classics and of modern science naturally crops up here. One or two brief rules might be laid down, helping to secure a firm general basis for the arrangement and comparative value of the several branches of college study.

1. The student should be expected to attend for at least half the year, say 25 weeks in all, at the proper work of their classes, apart from preliminary and final examinations.

2. Students should attend college classes and lectures five hours a day for five days in every week of the term. This would give 25 hours a week, or 625 hours for each annual course, and 1875 hours for the three years.

3. The number of points for the degree of B.A. should be made 1875 and should be apportioned among the various subjects according to the number of hours devoted to the study of them.

4. Students might then have absolute freedom of choice as to the subjects they wished to be examined upon. Two-thirds of the whole number—that is 1,250—might be the minimum for taking the degree of B.A.

5. When candidates for university degrees appeared from outside the colleges precisely the same numbers might be required of them under the same examination. But the subjects of examination should be confined to those taught in the affiliated colleges, and to the same comparative estimate of value.

Of course the subjects taught in any particular college will depend upon the judgment of the Governors, and upon the will of those who may from time to time provide endowments; and it is even desirable that a college should afford a certain variety of subjects beyond the absolutely necessary curriculum. But it were well that some definite course should be indicated, embracing both ancient and modern literature, philosophy, and science; in short, indicating the subjects in which a well-informed man might be expected to be instructed. To such a complete course the highest honours ought to be confined. For it is as well in this place to point out that a university or college course of education has not so much in view the professional knowledge or training which may be required for the definite occupations or pursuits of after life as that solid and liberal foundation of varied information and intellectual discipline upon which the after structure of professional acquirements may be safely and securely raised free from that bias and tendency to empiricism which an exclusively professional training is almost certain to produce.

Some such arrangement as the following would carry out the views now stated :—

For the first year : Greek language and literature, to occupy two hours a day, or ten hours weekly; Latin language and literature, mathematics, chemistry, one hour a day each, or five hours a week. This would give the full amount of twenty-five hours a week.

For the second year: mathematics and natural philosophy, two hours a day, or ten hours weekly; and English language and literature, natural history, chemistry, and physics, one hour a day, or five hours weekly for each.

For the third year: mental and moral science, two hours a day, or ten hours weekly; history and political economy, French and German languages and literature, applied mechanics and engineering (with mechanical drawing), one hour a day, or five hours weekly each.

Additional or alternative classes might be provided for Greek and Latin in the second year, for jurisprudence, logic, and rhetoric, to the extent of one hour a day each.

Under this scheme Greek would at the end of the course count for 250 points, Latin for 125, mathematics and natural philosophy, with applied mechanics, 500; moral and mental science, 250; chemistry and physics, 250; history and political economy, 125; natural history, 125; English language and literature, 125; French and German languages, 125; making in all 1,875 points.

The proportions of the various departments of study would thus be :—

Literature, ancient	375	
„ modern	250	
		625
Mathematics and natural science		875
Philosophy		375
		1,875

By taking into account the alternative classes, to which many more might in time be added, the highest literary course would admit of 750 points, the highest in philosophy 625 points, and the least scientific or mathematical 500.

It will be perceived that such a course prepares very directly for the more important occupations of after life, and affords the means by which technical instruction, properly so called, may be carried on. At the same time, the student who enters upon his professional studies after such a course is not at all likely to be unduly influenced by the specialities of his calling, or to have a prejudice against the improvements which may come from outside its ordinary routine.

In making such a summary as has now been given, it will be understood that students will require to devote well nigh as much time to preparation for their classes and revisal of their notes as they spend within the class-rooms. Without such continuous exertion their progress is not likely to be very marked. But ardent study to this extent requires a reasonable limit to the time devoted to it, hence the necessity for one rather long vacation for the sake of both professors and students. Although somewhat diffident as to giving a decided opinion upon the subject, I believe that two terms in the year would be preferable to three, and certainly more advantageous than one term or session according to the system of the Scotch colleges.

I submit these views as a contribution to the discussion of an important subject. It is especially desirable in view of the arrival of two additional professors to the staff of the Canterbury College that we should be prepared to give an impartial and dispassionate consideration to the claims of the subjects they are specially engaged to teach; and also, that they should be aware to some extent of the views entertained by those who possess at least the advantage of some colonial experience. A certain adaptation to circumstances is essentially requisite. In an age when every department of human thought is making such rapid advances, the method of instruction becomes itself a science, and is deserving of careful study in all its branches, from the most elementary to the highest. The aim of our colonial college is to place the highest education within the reach of all those minds which are best qualified to profit by it. And while we labour to make the general education of the mass of society as sound and as good as we can, we shall never more truly promote the interests of the human family than when we afford to the men of brightest intellect and most solid mental power, quite irrespective of class, rank, or wealth, the means of developing their faculties, and of accomplishing those higher ends which they only can reach.

At a late meeting of the Social Science Association in Glasgow the Earl of Rosebery complained that with all the talk there was about technical education no proposals were made to provide technical education for their rulers. He meant that the science of Government and the great questions of social well-being were not made so prominent as they ought to be. What he thus desires for Great Britain is still more necessary here, for the whole community are our governors. The strong active intellects, come from what class they may, are sure to be the leaders in such a land as ours. To provide for such intellects the soundest information and the best mental discipline is the surest means to preserve the liberties of the country from the attacks alike of the demagogue and the despot, and to promote throughout future ages the moral and material progress of its inhabitants.

Art. XIX.—*The Claims of Science in National Education.*

By Josiah Martin.

[*Read before the Auckland Institute, 27th July,* 1874.]

"No human pursuits make any material prosperity until science is brought to bear upon them."—H.R.H. the late Prince Consort.

I ask for myself this evening that courteous forbearance always accorded in a learned society to the maiden effort of a junior member, and in bringing this paper before your consideration I trust the importance of the subject will commend itself so thoroughly to your attention that you will bear patiently with any imperfections in the manner of its presentation.

No subject commands greater attention in the civilized world at the present time than the important question of education. The progress of modern discoveries having brought about vastly extended intercourse between nations, communities long separate and exclusive are brought into intimate relations with each other, and, consequently, a desire for accurate information stimulates inquiry, and upon closer intimacy men seek to possess in common the truths hitherto known to the few. The various agencies of civilization, by the diffusion of knowledge, have emancipated thought from the fetters of ignorance and superstition, and created a universal demand for a fuller revelation of truth than the stores of literature are able to supply.

To the arrangement and adaptation of *truth* and to *thought*, so formulated as to meet this demand by a graduated system of instruction, we here apply the term science.

We desire to advocate the teaching of science not as a mystic something demanding extensive knowledge for its comprehension, but as "progressive truth," starting from the simplest facts within the mental capacity of a child, and reaching to the utmost bounds of the loftiest intellect of man.

The world seems now to be awakening from the torpidity of past ages, and to be preparing for a future career, of the extent and influence of which we have yet but a dim foreshadowing.

Our purpose in the present paper is to show—

1. The claims of science as a department of national education.

2. The demand for science training in public schools.

3. The responsibility of the State for the diffusion of science knowledge among the people.

4. By illustration of the progress and results of scientific instruction to recommend its application to our present need as a colony.

Herschel has truly described the students of science as "messengers from heaven to earth, to make such stupendous announcements that they may claim to be listened to, when they repeat in every variety of urgent instance

that these are not the last announcements which they shall have to communicate : that there are yet behind to search out and declare, not only secrets of nature which shall increase the wealth or power of man, but truths which shall ennoble the age and the country in which they are divulged, and by dilating the intellect, react on the moral character of mankind."

The discoveries of a few noble minds have been the means of bringing countless blessings within the reach of the whole human race, and have given us the control over powers of which our fathers had but the faintest conception. The investigations of the *philosopher* are eagerly watched by the *inventor*. A secret has scarce been revealed from the treasury of nature when it is utilised for man's benefit and destined to enrich the treasury of thought or enhance his physical well-being.

The momentous question which presents itself is "How to spread the knowledge of science so that its advantages may be shared and enjoyed by all?" The mere exhibition of its effects is insufficient to enlighten the public mind. The electric telegraph, for instance, is an evidence and illustration of the progress of science, as also are the achievements of modern enterprise, which, while presenting in substantial monuments the triumphs of genius, and man's mastery over matter, yet their true educational value can be felt only by those whose previous mental training enables them to comprehend all that science has wrought in presenting such great results.

The claim for instruction in applied science is urged upon us from all classes of men. The mechanical work of the labourer requiring *less* expenditure of mere physical effort, *more* skill and scientific knowledge to direct even the simplest operations of his calling. As far as we can see into the future the wealth of our race must increase in the same ratio as its discoveries in science, if the inventor, the manufacturer, the engineer, the merchant and the artizan have the necessary culture to enable them to seize upon the new truths and extend their benefits over the greatest area.

Education is the development of the mind from infancy to maturity. The intellect of a child is the depository of latent power, it expands by the growth of thought, and is corrected and governed by external influences. As a community we recognise two departments of education—personal and relative.

First.—That duty which devolves upon those who, as parents or guardians, are personally responsible for training up the child to be true to himself. The virtues of self-denial, love, and obedience, and the sublime lessons of religion, can be taught only in their present form, in that Divine institution, the circle of a happy family. Parents cannot, therefore, divest themselves of this responsibility, and charge their neglect upon the State.

The second (or relative) department of education is that which prepares a

child for his duties as a citizen, and for this the State must, for its own security, be responsible. A right to the highest mental culture that can be afforded by any country is also the heritage of its children, a right with which the accidents of birth should not be allowed to interfere.

In the commonwealth many things can be better undertaken by the Government for the benefit of the whole, than by the individual for the benefit of himself. All agree that protection to person and property is the necessary duty of a Government, and this, to be effectually carried out, must include provision by the State for the education of its members.

Many advocates of national education maintain that the State need only supply the rudiments of education to those who, through poverty or neglect, would grow up in ignorance and be a burden upon the community. To open common or elementary schools is a necessary provision of the State, but the nation's duty cannot end here. The instruments of learning only open the gates of knowledge, and simple elementary instruction does not of itself prevent or diminish crime or increase the revenues of the State.

A national system must of necessity be scientific. In its primary schools the young should be trained in the first principles of science, and stimulated to delightful and profitable study. The very conditions of our existence require an early acquaintance with the truths of science. Schools of various grades must be provided, leading up to classes and colleges for the highest branches of human knowledge. Provision must also be made for the training of a staff of competent teachers, and for technical education adapted to the particular requirements of the district or country. A child will thus be prepared by the State to take his share in the struggle of life, ready to meet and surmount its difficulties, and help forward the great cause of human progress.

2. The demand for science training in public schools arises from the altered circumstances of our existence. The intellectual and industrial callings of the present day require very different attainments from those entering upon their service than in any era of past history. Natural science is required because the future life of every child will be a struggle with nature, and penalties for neglect of natural laws are being felt on every side. The State is responsible for the culpable ignorance which results in so much misfortune, sickness, and death. The laws of nature are invariable, and some elementary knowledge of them can be obtained with far less trouble than is often given to the study of ancient language, and the benefits derived are beyond comparison. What enormous advantages would accrue to the State if the laws of health and wellbeing were well understood and observed, and yet this most important of all subjects is rarely taught in a common school course.

Physical science must be taught, because man's best servants are the

forces of nature, and success in any station of life requires an acquaintance with these subtle powers. The highest rewards are held out to those who can best master these wonderful agencies and bring them into their service. It is, therefore, of supreme importance to the State that children should be made acquainted with the mighty energies which modern enterprise commands to do the bidding of man. The elements of physical science known as the "Erdkünde" of the German schools form a most important and interesting branch of preparatory study. It treats of the exhaustless treasures of our material earth in its mineral wealth, its vegetable productions or its mineral life, with the natural phenomena and climatic changes of constant occurrence. These subjects have received so little attention that the daily waste through ignorance is a serious loss in every country, which will become more and more apparent as population increases and civilization extends. How little is generally known of the air we breathe or of the food we eat, the nature of the soil and the crops it is best suited to produce, or of any of the necessary conditions of animal and vegetable life. *Nature* is the book from which our life's lessons are to be taken, in which we must study daily for success in business speculations, farming operations, manufacturing industry, mining adventure, or profitable thought and recreation. It is a book, the interest of which is ever increasing, and the teaching of which is of the highest importance. God's book, the Bible, can be taught at home, God's book of nature should be taught at school.

The prosperity of a country and the harmony and perfection of its laws will depend upon the spread of knowledge among its people. Self-government is the cry of the present age, the success of which as a whole rests upon the comprehension by each individual of the first principles of political or social economy. If a rifle is to be placed in a soldier's hands, military discipline requires that he shall be trained to use it; and so, if political power is to be placed in the hands of the people, it becomes the duty of the State to train them to use their influence for the common good.

Upon the testimony of the highest authorities the most important position in the education of the judgment, in the culture of the powers of observation, and in developing the resources of the mind, is assigned to the study of science, and no national system of education can be complete where it is omitted from the curriculum of its public schools.

3. The demand for technical education, or that systematic training necessary for every profession or calling, is felt in every trade and occupation, and the State should, for its own material prosperity, provide necessary instruction in the most important departments of practical education.

Commercial business now requires a scientific knowledge of the productions and resources of the world and an acquaintance with the history of modern

industry—the laws which influence production, supply and demand, international communications, shipping practice, freights, insurances, &c., must find a place in school instruction as a preparation for commercial life, and in evening training classes for those in daily employment.

Industrial occupations all require a knowledge of the elementary principles of mechanics and the physical sciences. Instruction in these departments can be given in our higher schools, and will enable the young manufacturer or artizan to understand the various processes with which he has to deal.

Agriculture now demands in the country that peculiar education which commerce requires in the town. And that the study of natural science can be made delightful and interesting to our rural populations is proved by the experience of all teachers who have taken the trouble to open the mysteries of nature and explain its operations to the wondering gaze of childhood. The eager desire for information, so strong in the young, may be stimulated into healthy activity as the mind of the child expands to receive and love the teachings of science with reference to his daily pursuits. Thus, by a diligent culture of the faculties of observation and reflection the foundation is laid for future success in advanced scientific studies.

An educational course should not be confined to the schoolroom, but classes should be held in the field, the quarry, the manufactory, and the museum, where nature may be seen at work, where mechanical operations may be examined and explained.

Drawing should form a daily lesson in all public schools. The youngest child will take great pleasure in this exercise, and the importance of early training in art cannot be estimated. The love of all that is beautiful in nature and art, if cultivated in the school, becomes a lasting source of pleasure, and finds expression in the exhibition of artistic skill in the humbler relations, as well as the higher callings of national life.

4. The German schools now present a most perfect and complete system of public instruction, and many States of Continental Europe have followed their example, and the result of their progress has astonished the world.

About twenty years ago the first attempt was made to transport the German system into English soil, and Mr John Rüntz founded the first Birkbeck school in London. Science training as the basis of education was the system adopted and most successfully carried out; two important facts were demonstrated to the public mind—First: That children could be made familiar by oral training lessons (illustrated by objects, experiments, &c.), with the elementary principles of physical science, and that they could, by sound business training, be fitted for the practical duties of life. Second: That the schools could be made popular and self-supporting. A staff of young men and women were trained as teachers under his care, and other schools were soon opened, which

are still prosperous and independent. The fees of all departments in these schools are from one shilling per week to one guinea per quarter.

The department of science and art of the Committee of Council on Education has been quietly doing a great work in promoting the industrial training of the artizan and encouraging technical education throughout the country.

The twentieth report recently issued gives the most encouraging accounts of the rapidly increasing spread of knowledge among the middle and working classes of the community. By a well-organized and carefully executed plan assistance is given to schools, classes, and institutions in exact proportion to the amount of work done by them, as proved by the actual results of their teaching.

Classes for instruction may at any time be formed by duly qualified teachers, under the supervision of a local committee in connection with any school or institution. The department requires that a minimum of twenty separate daily lessons, of one hour each, shall have been given to the students in each subject authorised by them.

Examination questions are prepared by professors of the highest standing, and are forwarded to local central committees, to be by them distributed to the students assembled as directed, and returned.

Payments to teachers are made at the rate of £2 for each first-class certificate and £1 for every second-class obtained by their pupils, together with prizes to the most successful teachers.

The class of students, on account of whom payment is made, is restricted to artizans or workmen, and all classes in the receipt of incomes less than £200 per annum, and all teachers or pupils of public elementary schools. The certificates to students are usually accompanied with substantial prizes in books, etc., as memorials of success.

The last report—the most encouraging yet issued—states that the number of science schools has increased from 153 in 1866 to 948 in 1872, and for the same period the number under instruction has increased from 6,835 to 36,783, and now stands above 50,000.

Examinations for 1872 were held in 597 provincial and 56 metropolitan centres; 19,568 students worked 39,383 papers, for which 27,806 certificates were granted.

The payments made to teachers upon these results amounted to £25,202 7s 2d (or 13s 8d for each person under instruction), in sums varying from £1 to £300, the average being about £26 per teacher.

The department also made grants towards the purchase of apparatus, diagrams, etc., amounting in the year to £757 11s 10d, and awarded prizes and medals to the value of £1,544 13s 11d.

Advanced scientific instruction is promoted by special courses of study for teachers at South Kensington, and for all classes at the Royal School of Mines, College of Chemistry, and the Metallurgical Laboratory, London.

Elementary drawing, as a part of national education, and fine arts applied to industry, form the second branch of the department. Under this head are maintained the National Art Training School, with 765 students, and 122 local schools of art, with a total of 22,854 students.

Aid is also granted to 538 night classes, with 17,256 pupils, and in 1,770 elementary schools 194,549 children were taught drawing.

The grand total of persons taught drawing, painting, or modelling in 1872, through the agencies of this department in England, Scotland, and Ireland, was 244,134. Training schools for teachers are maintained in the highest degree of efficiency, and grants are made by the department in aid of the purchase of the necessary apparatus, models, etc.

The educational and art museums of South Kensington, Bethnal Green, Edinburgh, Dublin, with several local exhibitions, also under the care of the department, have been patronised during the year 1872 by 3,795,000 visitors.

The total number of persons who received direct instruction as students in science and art in connection with the various agencies for the same period, amounted to nearly 299,000.

The total expenditure of the department for all its branches, charges, and expenses during the same financial year was less than £210,000.

Thus, while a simple calculation will show the cost per head of such instruction, no estimate can be made of the gain to the community through the increased intelligence of that class to which is due the nation's greatest material prosperity.

At the Liverpool Collegiate Institution, Cheltenham College, Eton, Harrow, Marlborough College, Sherborne School, Winchester, and Taunton Collegiate School, training in science and art has now become a recognised part of the school course, and the London School Board require by regulation 18 "systematised object lessons, embracing a course of elementary instruction in physical science, and serving as an introduction to the science examinations which are conducted by the science and art department."

With an unknown wealth of natural resources we are every day witnessing waste and loss through careless ignorance, and unless some measures are taken by our Government to provide a true system of education the next generation will feel the incubus of a heavy debt, without that knowledge which properly applied will enable our colony to meet all legitimate demands and become a wealthy and prosperous nation.

To establish and maintain in Auckland a school for practical education in

science and art, efficient direction, suitable accommodation, and adequate apparatus for instruction would be required.

The organisation of the Auckland Institute by its Council would offer the best guarantee for the direction and management of such a school, while the educational collections and library of the Museum, supplemented with apparatus for school classes, would offer exceptional advantages for instruction in the natural resources of this province. I trust that the importance of the subject will sufficiently commend itself to your approval, and that the required accommodation may be provided in connection with the Institute in suitable public buildings.

I feel convinced that if the experiment were fairly tried in Auckland, the superiority of a system of scientific training would be demonstrated, and the Colonial Government constrained to adapt to the increasing requirements of this colony a system of education which shall enable the next generation to make New Zealand the most prosperous nation in the Southern Hemisphere.

ART. XX.—*Early Instruction.* By J. ADAMS, B.A.

[*Read before the Auckland Institute, 26th August,* 1874.]

WHEN a traveller wishes to ascend a lofty mountain he employs a guide in order that he may go up by the easiest route, and at the same time obtain during his ascent the best view of the surrounding country ; but if the guide, instead of taking the best and easiest route, wished to force our traveller up the steepest side, where all his strength would be required to keep him from rolling to the bottom, and where nothing could be seen during the ascent but the rugged side of the mountain—I think such a guide would not be often employed.

Now the ascent of a mountain has often been used as a simile for the gradual acquisition of knowledge, in which the difficulties are greater or less according to the guide.

In real knowledge the conceptions agree exactly with the outer world and human life, just as the picture of the prospect formed on the retina and conveyed to the mind agrees with the outspread country, and as the prospect becomes wider and picture more complete as we ascend the hill, so also the ideas are enlarged and the conceptions made more exact by the acquisition of real knowledge. The learner is ever forming a clearer apprehension of the order of nature and striving onward to the knowledge of the truth.

It is an encouragement to know that from the moment the child enters this world he begins to acquire knowledge, which day by day and month by

month goes on increasing. He measures distances, he interprets signs, he detects the distinction in sounds, and after a time he expresses his ideas—not by signs but by words; while daily through the five channels connecting his soul with the outer world the mind receives ever increasing supplies of knowledge which it assimilates according to its capacity.

Before the child is five years old he can describe his perceptions, he can find his way about in his own neighbourhood; he connects events in their order, as when he looks for the people when he hears the church bell, or for the train when he hears the whistle of the engine. He knows and classifies trees and plants and animals. He will, even of his own accord, give a name to any object with which he often meets. In fact he displays a mind in full working order, with reason and memory ever active. In his own little sphere his conceptions agree in outline with the order of nature, coloured with all the charms of the partly unknown—the mind is of its own accord ascending the hill of Parnassus by a very delightful path.

At this age he is usually entrusted to a teacher to quicken his perceptions and to enlarge his ideas. The teacher at once puts our pupil to learn the twenty-six letters of the alphabet. The child is then shown the nine digits and zero; and then repeats perhaps a few lines of his catechism. In fact the child's mind, which has been up to this time chiefly occupied with its own perceptions, with the colours of the flowers and the song of the birds, is at once compelled to grapple with the most abstract ideas. The change is as great as if a man were suddenly transported from an Auckland summer to a Siberian winter. It is quite impossible for the mind of the child to assimilate these admirable abstractions.

We may associate the letters and figures with the advance of the human race in civilisation; we may know what a great advantage has been gained by adopting the Arabic symbols, and how superior they are to the clumsy symbols employed by the Greeks and Romans in their mathematical calculations. But to a child they have no association and no history.

The letters also have a long history; they can be traced back to the picture writing of men emerging from a savage condition. This kind of writing a child understands without a teacher, and long before he is sent to school he can read pictures. It appears then that from this point his instruction should naturally begin. Let him be shown the picture of an object, together with the word for the object, and action and reaction of ideas is at once aroused, and the word becomes associated with the object, so that very quickly he reads the word without the picture.

In like manner the relation of objects or phrases can first be shown by pictures, as well as the agent and its action which will convey the meaning of the written sentence. In this way the learner connects the known with

the unknown, and memory can work with pleasure when the link of association is supplied ; even the twenty-six letters are unconsciously learned after a time, and only require to be named.

In numbers also a child learns to count his marbles and divide his sweets before he goes to school, and his instruction should commence with the concrete rather than the abstract. The object of a teacher should be to connect the previous knowledge with the subject of instruction, otherwise no knowledge can possibly be acquired.

But it is not to be supposed that the child is better taught when he can repeat the alphabet. He is then put in possession of a Mavor's Spelling Book, where he spells words that he may need at some far distant future. In due time he learns to read, word by word, that is to say he has not the remotest notion of the subject. As he repeats the words no ideas are awakened, just as though he read in Hebrew or Greek ; whereas if he had been properly taught every phrase and every sentence would convey a vivid picture to the mind. The method employed in teaching the child to read is carried out in every other subject. He is driven blindfolded up the steepest side of Parnassus, with little care how bruised he may get as he stumbles onward.

As an instance I will take geography. Now the natural way of teaching this subject is to trace first the roads leading to the school, marking the position of well-known objects in the immediate vicinity, and then get the child himself to draw a similar plan. Afterwards to produce the roads to more distant objects in the neighbourhood, and so on to extend his ideas to the relative positions of the principal places in the whole country. There is no subject he will take a greater interest in as he finds that he can actually map down every place that he is acquainted with in the whole district.

The usual method is first to make the child commit to memory the names of the kingdoms of Europe and their capital cities, or indeed to begin with the latitude and longitude of the globe. He listens with astonishment, mingled with awe, to his teacher talking of meridians, the tropics of Cancer, the tropics of Capricorn, the equinoctial line, the vernal and autumnal equinoxes and suchlike terms. This is essentially a foreign language to our pupil, but it makes him wonder at the teacher's learning, and as every subject is taught in the same obscure way the pupil unconsciously associates his idea of great learning with that of unintelligible language. Later in life, from mere habit, he will listen with reverence to the most nonsensical discourse when couched in scientific language. I suppose for the same reason a song in a foreign language is much more heartily applauded than one in English.

The early impressions are always the most permanent, and early instruction tends in a great measure to produce the conviction that the working of a great mind can only be manifested in vague and vapoury language. Although

such discourses resemble too often the banquets of the theatre, where the seemingly rich viands are painted pasteboard, and the choice wines only coloured water.

The result of four, five, or six years preparatory instruction is easily given. Our pupil has gone through Mavor's Spelling Book, but he is unable to write an ordinary sentence in English without several mistakes in spelling. He can multiply and divide abstract numbers with great inaccuracy, but has no idea of applying this knowledge to any question in concrete numbers. He knows that the earth is like an orange, with a band round it called the equator. He can repeat the names of some towns in foreign countries, but does not know where they are situated. He can read, if one may so call a repetition of words, with no idea of the sense. He can repeat the nine parts of speech, just as in ancient times men learned to repeat the letters of the alphabet as a charm against witchcraft. What more he learns is of so vague a nature that it cannot be specified, such as that King Alfred let cakes get burned and was well scolded, or that another king killed six of his wives.

When we consider how much the child learns by the natural vigour of his own mind before he goes to school, and how little he gains during his early instruction, the conclusion must be that some improvement is necessary. He went to school to increase his knowledge of the world around him, and during five years he learns nothing from his teacher about distinction of colours, nothing about shape or figure, nothing about animals, trees, or flowers. In no respect are his perceptions quickened or his ideas enlarged, but on the contrary they are impaired from lack of use. It is really lamentable to find a naturally vigorous mind seriously injured by this absurd system.

"If not so frequent would not this be strange,
That 'tis so frequent this is stranger still."

The first instructor of a child seems, in most cases, not to know that memory is cultivated in any other way than by constant repetition of the words where the association is formed by sound alone. But before the child went to school he had constantly employed the higher methods of association of time, of place, and of cause and effect. That the memory works by these laws must not only be known to the instructor, but he ought also from the constant habit of employing them in his own studies unconsciously to impart them to the pupil.

It is most essential that a child should early become acquainted with the powers of the mind he possesses, not by name, but by actual employment of these powers; this is the greatest boon that a teacher can bestow. The opinion is gradually gaining ground that a competent teacher is as necessary for a child of four years old as for a boy of fourteen; but until most men

become convinced of this very evident truth, there will be some truth in the lines :—

> " When a man's the sport of heaven,
> To keep a school the wretch is driven."

The first great step in primary instruction will be made when the conviction becomes general that an incompetent teacher does as much injury to the young mind when most vigorous, as such a one fails to do good to those advanced in years ; but so long as it is thought that every one with a so-called good education can be a teacher we shall have no change in our present system.

If it is desired to correct any physical defect in a child, the best physicians are consulted during the child's earliest years, because the changes in the body during its development are more rapid than in later years ; and although it is acknowledged that the mind is equally susceptible of improvement and of injury during these years, yet the cultivation of it is generally entrusted to a man who has no conception how minds perceive or reflect or generalize—who would be surprised to hear that a teacher is very certain to do no little harm if he does not know in what way concrete ideas become abstract, and simple become complex.

A good teacher would develope and enlarge all that a child learns before going to school, so that the outer world would become better known every day. His eye would be quickened in detecting the diversity of the colours of the flowers and the variety of shapes in the leaves. His interest in animal life would also daily increase by the mind being directed to their habits and their instincts and their uses. During those four years now so shamefully wasted, the perceptions of a child can be so quickened, and his ideas so enlarged on objects of natural history, that a museum would become a necessity in every town for advanced schools on account of the stores it possesses for instruction in science and history.

Our fine collection of New Zealand plants would no longer remain shut up in the herbarium hid from mortal eyes, the collection of birds and fishes and reptiles would be examined for instruction, and not to merely gratify a vague curiosity which neither generalizes nor separates nor awakens any ideas that the memory can retain. I am of opinion that a clearer notion of the history of human life can be given by a comparison of the implements, ornaments and apparel manufactured by Maoris with those now used by the English than is at present conveyed by compelling a child to learn the domestic troubles of various kings and nobles in remote ages.

An institution such as this museum is unquestionably in advance of the times. The real worth of it will be felt when the subjects taught in schools bear upon the study of the works of nature and the appreciation of the

works of art. When such schools are plentiful the number of minds seeking for the useful in natural objects and the development of the æsthetic in works of art will be increased a hundredfold. But to accomplish this it is evident that there must be a decided change in the system of early instruction which will necessitate a corresponding change in advanced schools.

This change, I beg to observe, requires no Government aid and no increase of expenditure, but it requires a higher appreciation of the importance of the first four or five years of school life, and a general conviction that to become a teacher is not such a very simple matter.

The importance of a more judicious cultivation of the mental powers of a child will also appear from the fact that reason and memory preponderate the more over imagination the younger the child. When habits of observation are formed early by which the mind is directed for recreation to external objects an important check will be given to wayward fancies and castle-building, or more properly speaking, to subjective sensations, which are often the fruitful source of folly in youth and of discontent and misery in later life. The passion for sensational novels tells the tale of bad early instruction of incompetent teachers and of the waste of some of the most important years of human life.

I have read from time to time of masters of some advanced schools urging the necessity of preparatory schools in connection with their own, but the proposals have generally been coldly received. There is naturally a great hesitation in persisting in such suggestions because they are always attributed to some selfish motive, and there is also the fear in arousing the public who are content with the present system, lest, to use the simile of an old Greek, those whom it is intended to benefit may feel angry, like a sleeper suddenly awakened by a fly, and strike at the disturber of their rest. The necessity of good preparatory schools may be very evident to some teachers, but the people at large must feel the necessity of them before they can be established. At the same time it is certain that no very high attainments can be expected from boys of our schools so long as a very important part of school life is shamefully wasted. I do not expect any change in our present system for some years, but I believe the wrong done to young children is every year becoming more apparent, and in time the badness of our present method of early instruction will be evident to every one.

It is with this hope that I do like the traveller in Ireland, who comes to a cairn raised to mark some crime, when he throws a stone on the rising heap.

ART. XXI.—*On Forest Culture.* By J. C. FIRTH.

[*Read before the Auckland Institute, 26th October,* 1874.]

FORESTS exert varied and important influences in the economy of nature. They attract moisture and prevent a too rapid evaporation, holding the balance, as it were, between excessive droughts and disastrous floods. They add beauty and life to the landscape. They give shelter and homes to birds, who go forth with merry music from the greenwood to do battle on man's behalf with hosts of devouring insects. And to cut short the story of their uses they provide timber for all the varied wants of man.

Uses so apparent ought to have induced mankind to use sparingly, and even to cherish the "forest primeval." Yet from the most remote ages forests have been destroyed, as if they were enemies to be extirpated as quickly as the feeble power of their enemy could accomplish the suicidal work.

The effects of this destruction of forests are simply the legitimate result of a reckless and persistent disregard of a plain natural law. To strip a semi-tropical country of its forests is to convert it into an arid desert. In more temperate countries denudation of timber produces barrenness of soil, increases insect life, creates drought, diminishes rain, accelerates evaporation, causes floods and untimely frosts, lessens the production of food, diminishes population, and finally degrades a nation. The glory of many an ancient empire departed with its forests. To-day Persia and Spain present sad but warning spectacles of desolation and degradation which, though partially due to various causes, have been intensified by the destruction of their forests.

The destruction of forests by fire and saw in new communities presents a singular and striking instance of that indisposition to acquire wisdom by the experience of others, which is one of the enigmas of human nature. However, it is certain that if a great natural law be disregarded by new communities, results will follow similar to those which have attended its infraction by ancient nations. We have but to look back to the present condition of large tracts of the United States* to find that already nature is

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* The *New York Times* declares that the reckless destruction of the American forests is fast producing a condition in which there will be occasion for real alarm. In the whole United States, we are told, there is left but one really great tract of timber. It lies at the far extremity of the country, and consists of about one-half of Washington Territory and a third of Oregon. California has, perhaps, 500,000 acres of forest now, of which fully one-half has been cut away within the last two or three years. "Here, in New York, we have no considerable forest left, except in the Adirondack region. Railroads have been the means of levelling at least 150,000 acres of trees annually for ties, of which they use 60,000,000 annually. Fences are also enormous consumers of trees. The outrageous waste of timber caused by the felling of forests and burning of the trees to bring the land under cultivation goes on still at a fearful rate. From 1860 to 1870, no less than *twelve million acres* of forests were thus wantonly destroyed. For fuel, also, vast tracts are levelled of their trees. It took 10,000 acres of forest to supply Chicago with fuel in one year (1871). Our annual decrease of forest from all these causes is not far from 8,000,000 acres. Yet we plant only 10,000 acres of new forest a year. The necessity for a Commission of Forestry, and the need of efficient laws in all the States for the preservation of our forests need no further argument than these facts."

exacting one of her inflexible penalties. The reckless destruction of forests has developed such an increase of insect life in some of the States as to render the production of human food more and more precarious. Late accounts inform us that large areas have been devastated by swarms of grasshoppers, whilst in other districts the vast increase of the Colorado beetle has rendered the cultivation of the potato almost impossible. Indeed serious fears are entertained that unless some remedy can be found the cultivation of the potato will, from this cause, before long disappear from large tracts of America. This result will be mainly due to the denudation of the natural forest lands, and to the neglect to create forests on the vast prairies of the North American continent. The chief allies of man against the enormous increase of insect life are undoubtedly birds. Without forests birds cannot exist in sufficient numbers to render efficient aid in controlling this undue increase of the insectivorous tribes. It ought not to be forgotten that birds, more than any other agency, have been and are the great distributors of seeds and the chief planters of forests.

The attention of the Austral Colonies has not been directed to the conservation and creation of forests one moment too soon. The singular paucity of varieties of plants of economic value, of animals and birds in these colonies has led to the formation of those very useful institutions—the Acclimatisation Societies. It is not too much to expect that these organisations by wise, systematic, and well-directed operations will help to arrest the reckless destruction of forests as well as aid in creating new ones, and thus prevent the deterioration of our excellent climates, and by the introduction of insectivorous birds, will enable agricultural operations to be carried on with fairer prospects of success. Mr. Vogel, the Premier of this Colony, by his Forests Bill, has undertaken a truly national work, and is on that account entitled to the warmest thanks of every well-wisher to the present and future welfare of this and the adjacent colonies.

To me forest culture in this colony has long been of deep interest. In 1868 I pointed out to the leading Waikato settlers that their treeless and fern-covered plains would, as the fern disappeared, be subject to rapid evaporation, to untimely frosts, to droughts and floods, to the great increase of insect life, to the serious injury of their climate, as well as to the losses incidental to the scarcity of timber, unless steps were taken to form plantations. With the view of practically giving effect to my advice I at that time widely distributed amongst them large quantities of valuable seeds of the Coniferæ, and I have not failed to carry out practically my opinions by planting to a moderate extent on my own estates at Matamata.

I propose in this paper to treat the subject of forestry under two divisions :—

1. Forest conservation.
2. Forest creation and culture.

My remarks on forest conservation will apply chiefly to the Province of Auckland, there being doubtless many gentlemen in other divisions of the colony who will be able to do more justice in their respective districts to the subject than I can. For though, with the exception of the kauri (*Dammara australis*) and puriri (*Vitex littoralis*), and one or two other trees, there is a singular uniformity in the character of the arboreal vegetation of the entire colony, yet there is a wide difference in the development of many individual trees. For instance the kahikatea in the extreme north is a soft, woolly, and worthless timber, but becomes, the further south we travel, a more valuable wood. Again the white and red birches in the north are not timber trees, whilst in the south, I understand, they develope into large and valuable trees, suitable for a variety of purposes.

Though I do not concur in the statements made in the papers recently laid before the Assembly relating to the extent of the destruction of forests in the north I readily admit that a most reckless and wanton destruction has taken place, and is still going on at a constantly increasing ratio. Mr Vogel, in a speech delivered in this city some months ago, pithily said that a man would recklessly burn down a forest to light a pipe or boil a kettle. In truth our magnificent forests of kauri are being ruthlessly destroyed. It is not so much that noble kauri trees requiring 300 years to bring to their present perfection of beauty, strength, and grandeur are every day being cut down to build wooden houses, which will be rotten in 30 years, but it is the utter recklessness displayed by saw-mill proprietors, bush contractors, and splitters which is destroying our forests at a rate constantly increasing. In times not very far back, probably not much more than a century ago, the whole of the fern-covered plains of the North Island, north of a line from Whangaroa Harbour to Tauranga, were covered with dense kauri and totara forests. Small portions of these have been destroyed by the Maoris for cultivation, but fire has been the chief agent in stripping our plains of trees. In exactly a similar manner every patch of forest is still being attacked by fern fires, lit by the carelessness of settlers and natives. From these causes the almost total destruction of the forests of the North Island is but a question of time, unless stringent measures are taken to conserve them.

The kauri especially is doomed to extinction, except the young trees, saplings, and seedlings are carefully preserved from injury by man, cattle, or fire. Unquestionably Government ought not to sell for cultivation any forest land; forest lands in the hands of natives ought to be purchased by Government as quickly as possible. Lands over which saw-mill proprietors have secured cutting rights ought also to be purchased with the view of

preventing unnecessary destruction of trees other than kauri, most of which will yet prove of great economic value, and all of which are invaluable on climate account, with the object of preserving the young growing timber of all kinds, also for the purpose of closing up all forests out of which the larger kauri trees have been cut, so that the kauri may have a chance to grow undisturbed in its native habitat. I am convinced, if even this latter precaution be taken, that millions of kauri trees, from the tiny sapling to trees of, say, two feet in diameter, will be preserved for the use and ornament of the country for centuries to come.

Under the present system we are destroying our noble forests, the growth of centuries, and to this day (except by Mr Vogel's Forests Act) we have not made even an effort to stay the reckless tide of havoc and ruin which is sweeping them away. We are neither conserving the old nor creating new. If a squatter, having come into possession of a rare, valuable, and unrivalled flock of sheep, and, without taking a single step to perpetuate the famous breed, should proceed to boil down the entire flock, young and old, he would be denounced as a lunatic or a public enemy, or both. Yet we are now busily engaged in perpetrating a similar or worse enormity.

Acquired rights must of course be respected, nor will it be wise needlessly to check the timber industry, for there is undoubtedly an immense quantity of ripe kauri trees representing a large value in money, which are now at their prime, and which are being converted into marketable timber to the great advantage of the colony. At the same time there cannot be a doubt that this can be done without allowing the heads and branches of the trees to fall and lay pellmell amongst the young growing trees. The rough and ready system at present in full swing bruises and crushes down the young trees and provides fuel to destroy the whole forests, and so neutralises the efforts nature is making to redress the havoc and ruin we are so thoughtlessly causing.

Forestry as practised in Europe can only apply to the cutting of timber in this colony in its general principles, because our trees are very much larger than those cut down in European forests. This will be evident from the fact that kauri and many other forest trees range from 3 feet to 9 or 10 feet in diameter, and grow on the sides of valleys or gullies more or less precipitous. It is not, indeed, easy to see how trees of these diameters, frequently running up to 70 or 80 feet without a branch, and crowned with noble and spreading heads, can be felled without inflicting great damage upon the surrounding young timber. As I have already observed, acquired timber rights must be respected, and it may probably be only in kauri forests, acquired or to be acquired by Government, that such conditions can be imposed as will cause as little damage as possible. All such forests may and ought to be effectually

closed until experience has developed some judicious system of felling the ripe timber in such a way as to inflict as little damage as possible upon the young and growing timber. With the view of minimizing the damage to forests in the hands of private persons, the first efforts of Government ought to be directed to securing the forests out of which the large timber has been or is being cut, and which then being of no value to saw-mill proprietors may be acquired at a nominal cost.

These abandoned forests when so acquired ought to be absolutely closed so that the innumerable seedlings, saplings, rickers and spars may be secured from further damage by fires and cattle. If nature be so assisted, even to this extent, I am satisfied that we may hope for the renovation and restoration of our kauri forests. For the kauri being the most difficult of all our New Zealand trees to raise, cannot so easily be preserved for the use of future generations in any other way, and under any other conditions than those which nature has provided in its native habitat.

Much may be done by transplanting kauri and other seedlings in the denuded kauri forests; and in order to encourage the growth of seedlings it is very important that Government should arrange with saw-mill proprietors to leave standing at frequent intervals kauri trees of ripe timber, so that by the dropping of their cones, and by means of the kaka and other native seed-eating birds, a constant supply of seedlings may be secured. It is hardly necessary again to observe that the kauri will not grow south of the 38th parallel of latitude.

I have before observed that one fruitful source of the destruction of forests arises from fires. These fires are greatly encouraged by the heads of the kauri trees being left to decay and so providing ready fuel for fires kindled by the careless hands of the bushmen and others. It is useless to expect saw-mill proprietors or their contractors to incur an expense of two or three pounds per tree to put kauri heads with their massive branches out of harm's way. But if it can be shown that these heads and branches can be utilised so as to give them a commercial value representing a considerable percentage of the value of the trunk of the tree the difficulty of dealing with them will disappear. Let us see whether this can be done. The kauri heads or crowns consist of three parts.

The crutch or point of insertion of the main lateral branches, varying from 10 to 25 feet in length.

The large limbs more or less crooked.

The remainder of the head consisting of smaller branches.

The crutch is cross-grained, the straight "grain" of the lower part of the tree being twisted round the "knots" into a great variety of wavy, transverse, and oblique lines, and showing what cabinet-makers call "figure." Many

years ago I pointed out that the "crutches" would make handsome furniture. I again urge upon saw-mill proprietors, master-builders, and cabinet-makers the advantage of using the crutches. Stripped of their branches they could be floated down the driving creeks with the ordinary logs, and if "broken down" or cut into suitable boards for wainscoting and furniture, would be highly appreciated for their striking beauty.

Some of the more unique planks or boards might be cut into veneers, not only for local cabinet-makers but for export to London and elsewhere.

Some of the large limbs may be used for crooks and knees for ship-building, to take the place of the limbs of the pohutukawa (*Metrosideros tomentosa*), which are so rapidly disappearing under the constant and increasing demands of shipbuilders, or, together with the upper portion of the trunk, they may be sawn into second-class timber, used for mining purposes, or split into palings, shingles, and staves.

The smaller branches remaining may be converted into tar.

In this way one chief danger from fires would be removed, greatly to the advantage of saw-mill proprietors and of the country generally. Before I finally dismiss the kauri I may properly direct attention to the singular shrinkage, both longitudinally and laterally, of kauri timber. I have no doubt that these serious defects arise from the practice of "falling" the kauri all through the year. For ten months of the year the cells of the kauri are more or less charged with sap. To this cause probably is due the shrinkage I have noted. The brittleness and premature decay of three-fourths of the kauri timber arises from this cause alone. When a tree is cut down with the cells more or less charged with sap a chemical action probably takes place, which partially dissolves and destroys the cellular tissues and results in the decay of a timber in a few years, which, if felled at a proper time, would continue durable for centuries. From long observation I am satisfied that there are only two months of the year in which kauri, or indeed any trees in the North Island of New Zealand, can be cut down to prevent contraction and secure durability. These months are July and August, and of these months August is the best. Now it is not to be expected that saw-mill proprietors can find men to "fall" kauri only during these two months without having to pay very much more to the men engaged in "falling." A very simple plan will, I think, enable them to overcome the difficulty. During these two months, July and August, let them "ring" the trees, that is cut out a ring of bark and sap 3 or 4 inches wide round all the trees they intend to cut down or "fall" during the next 12 months. This simple plan will reduce the contraction to a minimum and secure what is more important, viz, the durability of the timber. The noble kauri, the king of our New Zealand forests, is capable of producing a timber for general purposes hardly second to

that of any known tree. When properly treated, for durability, toughness, elasticity, strength, and beauty combined it is not to be surpassed. It is really a great reflection upon us that we have hitherto neglected to take any measures to secure the full economic value of the timber of this noble tree.

Under the Forests Act of 1874 Government can, without much difficulty, conserve the valuable trees, which have as yet, from their limited consumption, not been subjected to much diminution, such as the rimu (*Dacrydium cupressinum*), totara (*Podocarpus totara*), rata (*Metrosideros robusta*), puriri (*Vitex littoralis*), tanekaha (*Phyllocladus trichomanoides*), maire (*Santalum cunninghamii*), kowhai (*Sophora tetraptera*), mangiao (*Tetranthera calicaris*), and titoki (*Alectryon excelsum*), all of which have invaluable properties fitting them in a very high degree for various industrial purposes.

2. Having thus explained my views of forest conservation and utilization I proceed to deal with the second part of my subject, "forest creation" or "culture." The questions which meet us at this point are:—What trees ought we to plant? Native trees, or deciduous trees and evergreen trees not natives of New Zealand?

Native trees have not as yet been extensively planted, and have not succeeded well. For many years I have planted them, but with so little success as to be more than once on the point of abandoning any further attempts. Experience has taught me, however, that though many of our native trees have been found difficult to rear, they may be successfully grown if due precautions are used. Shade and moisture (being the natural conditions of all New Zealand trees) must be artificially provided when they are transplanted into the open. And above all since the two root systems, that is, surface rootlets and the tap root, are characteristic of most of them, both must be fostered or the tree will fail. It has been too much the practice to develope the surface roots by destroying the tap root. This course lies at bottom of the great want of success so painfully apparent. When a kauri seedling of not more than two inches high, with a tap root of twice or thrice that length, is placed by a nurseryman in a pot of three inches deep the tap root is either broken or twisted into the pot in such a way as to render the young plant sickly, and it is not surprising that failure is the result. The tap root must be carefully protected. These remarks apply to the rearing of all our chief forest trees. I am satisfied that if the conditions I have laid down be observed the kauri, rimu, maire, rata, mangiao, titoki, totara, puriri, and pohutukawa will succeed. The three latter deserve particular notice, because they are more easily reared, and are more rapid growers than any of the others, besides being the handsomest and most valuable of our hardwood trees. It must not, however, be forgotten that for timber purposes most of our native trees require a century to elapse from the seedling before they will become available. For

instance every foot in diameter of a kauri represents half a century, and the average age of the kauri trees now being cut down is about 200 years. At the present rate of consumption of kauri timber it is not improbable that thirty years will exhaust the forests now held by our saw-mill proprietors (with one or two exceptions). There will of course remain the forests already acquired or being acquired by Government, and which, if firmly preserved for that time, and then judiciously worked, will yield an enormous revenue for a long period.

It will be evident from the foregoing considerations that other means than planting native trees must be resorted to if the large and constantly increasing demand for timber is to be supplied.

Deciduous trees embrace many examples of valuable timber trees, such as the oak, elm, sycamore, ash, and beech. I do not think, however, that we have the necessary conditions of climate and soil in the province of Auckland, north of the 38th parallel of latitude, suitable for the healthy development of deciduous trees. Many of these trees require a climate with cold winters, so that the activity of the five months of growth may be followed by seven months of repose.

Now, north of the 38th parallel the period of growth is much longer, and the period of repose much shorter, and we have in these altered conditions I think one reason for the marked failure of deciduous trees. One other inimical condition exists in the fern vegetation with which all our plains are covered. Deciduous trees, like artificial grasses, do not succeed on fern lands, unless the land has been "sweetened" by prior cultivation or by calcareous deposits, either artificially applied or already existing in the soil. South of the 38th parallel where the winters are more severe the vitality of the fern is not so great and grassy plains make their appearance. In such districts deciduous trees will have more of the conditions they require and will succeed better. Whether these or other causes are in operation to produce the want of success I have noticed further experience will determine. In the meantime we must look to other sources for our future supplies of timber.

Whenever Government acquire the treeless plains lying between Cambridge, on the Waikato river, and Lake Taupo, the opportunity will have come for extensive plantations of totara to be made, as, in the few existing isolated forests, such as the Waotu forest and other small patches near Lake Taupo, the totara thrives well and grows to a large size. On these grassy plateaux deciduous trees will I think succeed. In both cases belts of the Coniferæ must be planted as "nurses" to shelter the plantations of native and deciduous trees. It is not improbable if plantations of Coniferæ be established on our treeless plains that they will serve as "resting places" for birds on the wing from one distant wooded range to another. In this manner the kaka

and other birds will deposit the seeds of many native trees among the young plantations of Coniferæ, and in return will carry the seeds of the latter to the ranges clothed with native forest.

In concluding this division of forest cultivation I trust I have shown that if judicious and well-sustained efforts be made to create forests of our most valuable native trees, it is not unreasonable to hope that we shall be enabled to transmit to our descendants the wealth of timber suitable for every industrial and economic purpose which our native trees possess.

Desirable as it may be that great and sustained efforts should be made by Government to create forests of our native trees, it is, however, clear from their slow growth that they can only become useful as the forests of the far off future, and I pass on to the consideration of the important question, "What trees ought we to plant for use in the immediate future?"

After long and careful consideration I am convinced that our efforts in the direction of forest creation must be mainly directed to raise forests from the two great orders of the *Eucalypti* and *Coniferæ*.

Many of the *Eucalypti* succeed well on our clay soils, growing with great rapidity. One variety, the blue gum (*Eucalyptus globulus*), the "anti-fever tree," has acquired an importance in Europe, India, and elsewhere, which, together with its many valuable qualities, ought to induce us to cultivate it extensively. The red gum (*E. rostrata*), stringy bark (*E. gigantea*), peppermint tree (*E. amygdalina*), grow to a large size and have many valuable properties. Another variety, the jarrah (*E. marginata*), is said to be very durable in sea water, not being subject to the attacks of the *Teredo*. In the province of Auckland hundreds of thousands of acres of stiff clay lands, worthless for pastoral or agricultural purposes, might be planted with varieties of *Eucalypti* with very great advantage.

If large tracts were thus planted great benefit would be derived by all adjacent lands which are now sterile, by rendering them much more suitable for grazing and agricultural purposes, besides yielding a large revenue at no distant date to those who plant them, whether Government or private persons.

In Mr. Vogel's Forests Act, 1874, Government obtained powers to expend £10,000 per annum in forest cultivation, etc., but failed to secure authority to take the necessary lands on which to conserve or create forests. Under these circumstances I have addressed a letter to the Colonial Secretary, pointing out that in at least one district in this province Government possesses a large tract of land admirably adapted for the cultivation of the blue gum; that district being the tract lying between Meremere and Rangiriri in the Lower Waikato. This tract of land is a stiff sterile clay and quite unsuitable for agricultural operations. It is bounded on the west by the Waikato River, and on the east by the Mercer and Ngaruawahia railway, now in course of

construction, and contains many thousand acres. It is probable that this land is rich in coal and iron, the future working of which would be greatly facilitated by the surface being covered with a class of timber well suited for mining purposes. I have pointed out to the Colonial Secretary that, apart from this prospective advantage, the covering of these bleak hills with forest would enable the Government in a few years to supply by river and road the treeless Upper Waikato country with timber for fencing and other purposes, practically inexhaustible. Though I have chiefly directed attention to the blue gum, that is not because the great order of the *Eucalypti*, with its 150 varieties, has not many trees suitable for this colony, but that the *Eucalyptus globulus* is a proved success amongst us.

I now invite your attention to the great natural order of the *Coniferæ*. As I have already stated, my own experience has taught me that whilst our fern lands will not, from their "sourness," grow the deciduous trees to any advantage unless the land is well cultivated, these same fern lands (if of a sandy or loamy nature) will grow the *Coniferæ* most luxuriantly without any previous tillage. Perhaps I shall best illustrate this by describing the results I have obtained in pine cultivation at Matamata. I shall not weary you with the story of my many attempts and of my many failures before I finally succeeded. I shall shortly tell you what I have done and how I have done it. Four years ago I sowed the seeds of *P. insignis*, *P. radiata*, *P. maritima* and other varieties of the *Coniferæ* in my garden at Matamata. I then fenced in the tract of fern land I intended to plant. Burning off the fern I opened out with a single-furrow plough a furrow right and left, thus leaving a double furrow 18 inches wide and 4 inches deep. I then put a subsoil plough into this broad furrow, stirring the subsoil for 9 inches more. I repeated this operation at equal distances of 12 feet over the piece of land I intended to plant. When the pine seedlings were ready to plant (July) I put a man to make holes at 9 feet apart down the centre of each double furrow. This he did with an ordinary 1½ inch crowbar, which he held by one end in both hands vertically before him. Dropping the lower end of the crowbar into the subsoil and giving it a circular turn he drew it out, having made a conical hole 9 inches deep and 3 inches wide at top. Stepping on three paces he repeated the operation until he came to the end of the double furrow. He then returned along the second furrow making holes as before, and so on till holes were made in all the furrows. A dray was then sent to the seed beds, and passing a spade under the end of the first drill a spadefull of seedlings was lifted and placed carefully in the bottom of the dray, repeating the operation till the bottom of the dray was covered. The dray was then sent to the ground already prepared. Five men were each provided with a pouch made from a 100lb flour bag by cutting down the upper half of the bag.

Thus cut down, the bag or pouch was tied round the waist. A spadefull of seedlings was soon placed in each pouch, and each man took a furrow, putting a seedling into the first hole in his furrow. Drawing the earth round the seedling with his hands and then pressing the foot round the seedling the operation was completed, and so on till the whole piece was planted. By this mode six men made the holes and planted two acres each per day.

Three years have elapsed since this piece was planted; not more than five per cent. of the seedlings have failed, all the rest have succeeded admirably. The *Pinus insignis* shows most growth. Some of these had attained a height of ten feet, and yet in the same land all the deciduous trees have failed. I can only account for the vigorous growth of the *Coniferæ* from the fact, well known to geologists and naturalists, that the natural succession of plants is first mosses, next ferns, and then *Coniferæ.* It will be seen that I have not adopted the usual plan of transplanting the seedlings for one or two successive years into fresh beds, known as "establishing" the plants. Some nurserymen after the first transplanting pass the spade under the young plants to cut off the tap root. By this system the tap root is weakened and the surface roots developed. This plan probably renders the transmission of the "established" plants more easy, and may answer for trees planted merely in shrubberies for ornament. But if the object be to plant a forest, no system could be more fatal. The same remark applies to the treatment of native seedlings obtained from our forests. Most of these have tap roots, and if these are cut, broken, or cramped in pots, failure will be the necessary result. All the *Coniferæ*, and indeed most trees of large size, are provided with tap roots to take deep and firm hold of the ground, to enable their lofty trunks of from 100 to 200 feet high to resist the enormous pressure to which they are exposed by heavy gales of wind.

I have before stated my opinion, and I reiterate it here, that the forests in this part of the colony for use in the immediate future—say after the next thirty years—*must* be mainly of the *Eucalypti* and *Coniferæ* families, as representing hard and soft woods for general purposes. Information as to the varieties of the *Coniferæ* likely to succeed best in this colony being desirable, I have prepared from various sources the following list, showing the native habitat, heights and qualities of about fifty varieties. Nearly all of them will, I think, succeed well throughout the colony, but most of them prefer a sandy, loamy soil. As to the quality of their timber, I give that, as far as possible, as found in their native habitat. Most of them will doubtless undergo considerable alteration in this respect in this colony, the timber of some being improved, of others deteriorated.

Name.	Native of.	Height in Feet.	Timber.	Yields.	Soil.	Remarks.
Pinus sylvestris ... Scotch fir.	Northern Europe	...	Good	Pitch and turpentine	Dry	
Picea strobus ... ... Weymouth pine.	Europe	150	Good	...	Sandy	Suitable for spars.
Picea pectinata ... Silver fir.	...	100	Durable under water	Resin	...	Handsome tree.
P. laricio ... ... Corsican pine.	South of Europe	100 to 130	White, elastic, durable	...	Any	Ornamental.
Var. of *P. laricio* ... Black Austrian pine	...	...	Very resinous	...	...	Resists water and dry rot.
P. maritima ... ... Pinaster.	South of Europe	60	Not first-class	Resin	Dry, sandy	Good firewood.
P. macrocarpa ... Coulter's pine.	California	80 to 100	...	Edible seeds	Dry	Handsome tree.
P. ponderosa ... ... Heavy pine.	Oregon	100	Valuable	...	Alluvial	Hardy, rapid growth, noble appearance.
P. radiata ... ... Radiated pine.	Upper California	100	Tough and excellent, suitable for boat building	...	...	Grows best on or near the sea coast.
P. sabiniana ... ... Sabine's pine.	California	120	White and soft-grained	Edible seeds and resin	...	Handsome tree.
P. lambertiana ... Lambert's sugar pine	California	150 to 200	White, soft, and light	Large edible nuts and resin	Sandy loam	Magnificent tree.
P. insignis ... ... Oregon pitch pine.	Oregon	100	Fair	...	Loam	Well known.
P. monticola ... ... Mountain pine.	California	'100 to 120	Valuable	...	Sandy	
Abies excelsa ... ... Norway spruce.	Norway	100 to 150	Good	Burgundy pitch and spruce beer	Any	Bark suitable for tanning.
A. menziesii ... ... Menzies' spruce.	California	70 to 100	Excellent	...	Moist	
A. nigra ... ... Black spruce.	North America	75	Good	...	Moist	

NAME.	Native of	Height in Feet.	Timber.	Yields.	Soil.	Remarks.
A. smithiana ... ... Himalayan spruce	India and China	100 to 150	Indifferent	...	Gravelly	Remarkably handsome.
A. pattoniana ... ... Giant spruce.	California	300	...	...	Dry gravelly	Noble tree.
A. engelmanni ... Engelmann's spruce.	Mexico	60 to 100	Soft and white	...	...	Timber much used for inside and cabinet work.
A. canadensis ... Hemlock spruce.	North America	70 to 80	Indifferent	Bark for tanning	Alluvial, loamy	Very beautiful tree.
A. douglasii ... ... Douglas' spruce.	British America	150 to 200	Firm and heavy	...	Dry sandy loam	Stately tree.
A. bracteata ... ... Silver fir.	Oregon	120	...	...	Dry	Beautiful tree; grows at a high elevation.
A. nobilis ... ... Noble silver fir.	North California	200	Excellent	...	...	Majestic and magnificent tree.
A. pectinata ... ... Common silver fir.	Europe	100 to 150	Hard elastic	...	...	
A. amabilis ... ... Lovely silver fir.	Oregon	250	...	...	Gravelly	Most handsome tree.
A. grandis ... ... Great silver fir.	North California	250	White, soft	...	Dry, alluvial	Splendid tree, hardy.
A. webbiana ... ... Purple-coned silver fir	Himalaya	80 to 90	Soft, odorous	Resin, and a purple pigment from fruit	...	Very striking and elegant tree.
A. veitchi	Japan	120 to 140	...	...	...	
Cedrus atlantica ... Mount Atlas cedar	Mount Atlas, Africa	80 to 100	...	...	Dry	
C. deodara	Himalaya	130	Very durable	...	Dry	Magnificent tree, weeping branches.
C. libani ... ... Cedar of Lebanon	Palestine	...	Soft, perishable	...	...	Very ornamental and large.
Sequoia gigantea, or *Wellingtonia gigantea*	California	260 to 300	Good	...	Sandy	Majestic tree (one 3,100 years old, and contained 250,000 feet.)
S. sempervirens ... Red wood.	California	270	Red, close grained, not attacked by insects	...	...	

Name.	Native of	Height in Feet.	Timber.	Yields.	Soil.	Remarks.
Larix ... ... Larch.	Europe	80 to 100	Good, very durable	Venice turpentine, bark used for tanning	Loam, or moderately moist	Of great beauty, rapid growth, white larch pays sooner than most timber, difficult to transplant.
Araucaria imbricata ... Chili pine.	South America.	100 to 150	...	...	Dry, rocky, or sandy	Superb tree.
A. cunninghamii ... Moreton Bay pine.	Queensland.	100 to 130	Fair	...	...	Delicate tree.
A. excelsa ... ... Norfolk Island pine.	Norfolk Island.	220	...	...	Dry	Well known.
Juniperus virginiana Red cedar.	Mexico	30 to 40	Exceedingly valuable odorous	...	...	Timber much used for ornamental work, lead pencils, etc.
Thuja gigantea ... Arbor vitæ.	Oregon	100 to 150	...	...	...	Stately tree.
Cupressus lawsoniana Lawson's cypress.	Northern California	100	Good, easily worked odorous	...	Dry	Most graceful and handsome tree.
C. macrocarpa ...	Upper California	...	...	...	Any	Very fine tree.
C. sempervirens ... Upright cypress.	Italy and Turkey	50	...	...	Dry	Well known.
Cryptomeria japonica Japan cedar.	...	60 to 100	Good ; white	...	Sandy loam	Used largely in Japan for cabinet-ware.
Taxodium distichum ... Deciduous cypress	Southern States of America	100 to 120	Of inestimable value, soft, strong, elastic, and durable	...	Moist, alluvial	
T. mexicanum ... Mexican cypress	Mexico	200	...	...	...	Sometimes attains a diameter of 33 feet.
Dacrydium franklinii Huon pine.	Tasmania	100	Good	...	...	Handsome.

In concluding this paper permit me to recapitulate the points I have endeavoured to establish :—

1. The reckless destruction of forests must be put an end to.

2. No forest land to be sold for cultivation.

3. All denuded forests to be acquired, planted, where necessary, with native seedlings and *Coniferæ*, and closed, to give nature an opportunity to repair damages.

4. All virgin forests to be acquired and closed for the present, leaving the supply of timber to be provided, as now, by saw-mill proprietors from the forests over which they have acquired rights.

5. These rights to be respected.

6. Large areas to be planted as soon as possible in various parts of the colony with trees of the two great natural orders of the *Eucalypti* and *Coniferæ*.

Manifestly these objects can only be accomplished by the Government of the colony.

II.—ZOOLOGY.

Art. XXII.—*On the Ornithology of New Zealand.*

By Walter L. Buller, D.Sc., F.L.S., F.G.S., F.R.G.S.

Plates VII. and VIII.

[*Read before the Philosophical Institute of Canterbury, 28th October,* 1874.]

Ornithology, like every other branch of natural science, is progressive, and this is especially the case in a country like New Zealand, where the charm of novelty tends to keep alive a spirit of inquiry and to promote habits of observation. The fact that my recently published work on the Birds of New Zealand is already out of print, while there is a very general call for a new and revised edition, is satisfactory evidence of the increased scientific activity in our midst, and may, I think, be accepted as a fair indication that ornithology is becoming a favourite study in the colony.

If we are to succeed in getting a thoroughly true and exhaustive history it can only be by thus awakening general interest in the subject, and by encouraging those who have opportunities for observation to note down and place on record any fact or occurrence that may strike them as new or interesting in the habits or domestic economy of our native birds.

In order to work out satisfactorily this or any other branch of zoology we require the co-operation of a number of independent observers in various parts of the country, and the affiliated societies of the New Zealand Institute, as now constituted, present to all such workers a favourable medium for placing their observations on record.

Although much has been written about the Birds of New Zealand it is quite a mistake to suppose that the subject is exhausted. In the natural history of even the commonest species, closer observation will continually bring some new fact to light or develope some new feature of interest; and in the case of many of our rarer birds, we at present know really very little of their habits, and absolutely nothing of their nests and eggs or manner of rearing their young. Even with so common a bird as the Woodhen (*Ocydromus australis*) there is work still left for the field naturalist. The species presents so much variety in size and style of colouring that the inquiry into the existence of local races becomes very interesting. Captain Hutton, who

has written some notes on the subject (Transactions of N. Z. Institute, Vol. VI., page 110), considers the differences sufficient to warrant their separation into species, but his admission that one form may be only a "sub-species" of the other, reopens the whole question, for a bird must belong either to one recognised species or to another, and if these forms run into each other by gradations of size and plumage, however numerous, they must all be considered to belong to one and the same species. The collection of such a series of specimens as would satisfactorily settle this point is as much the work of the field- as the cabinet-naturalist.

Nor need the student of ornithology in New Zealand despair of finding fresh species and gratifying the pardonable ambition of attaching to a newly discovered form an imperishable specific name. Many portions of the country are only half explored, especially the mountain fastnesses of the Southern Alps and the rugged wooded country on their western slopes. The south-west coast of the South Island has been scarcely visited, and there are many hundreds of miles of sea shore as yet undisturbed by the fowler's gun. In the extensive marshes also of both islands new birds may be confidently looked for. The natives describe three or four different kinds of Rail which formerly existed in the wet swamps or along their edges, the disappearance of which they attribute to the ravages of introduced dogs and cats. It is not unlikely that a remnant of these may still exist in the remote and uninhabited parts of the country.

Our sea-birds again (especially the great section of Petrels) are very imperfectly known, and we have much to learn respecting their breeding habits and general economy. The South Pacific is the great nursery of this family, and we may rest assured that there are some species not yet described. Many of these birds never approach the land, but during heavy gales some of the smaller species are frequently cast ashore, and are to be picked up either dead or in an exhausted state on our ocean beaches. Novelties may always be looked for among these "waifs from the sea."

We hear from time to time of the grand *Notornis mantelli*, and no doubt a remnant of the race still survives in the back country to reward the collector's zeal and to enrich our local museums. The diminutive Owl, of which we have lately heard so much, still eludes the grasp of the naturalist; and other birds of which the intelligent settler speaks with confidence, are as yet "unknown to science." We must be careful, however, as to the amount of confidence to be given to the accounts of ordinary observers, for we all know how apt such people are to get wrong impressions of the objects they see. For example, I once heard a farmer describe a bird which he had seen, and which turned out to be an *Apteryx*, in the following terms:—"It was a fine large bird with dark plumage, something like a duck, but more like a turkey!"

Observations on the range and habits of our birds is the kind of information that we look for from residents in the country, and are most desirous of encouraging. But for the guidance of those who may be anxious to go a step further and describe for themselves any new form that may be discovered, I beg to offer the following hints and suggestions :—

It is comparatively easy to describe a bird for all practical purposes, that is to say, with sufficient definiteness to entitle the description to general respect, and to establish the author's claim to the right of priority in naming the species. The first thing to be done is to take the measurements, and in expressing these the formula of inches and decimal fractions will be found the most convenient. The following are those which are usually considered sufficient :—The extreme length ; the full extent of the expanded wings ; the wing from the carpal flexure to the end of the longest primary ; the tail, from the root to the end of the longest feathers ; the culmen, measuring from the base of the mandible to the tip, following the curvature, if any ; the lower mandible from the gape to the tip ; the tibia, if bare ; the tarsus ; the middle toe and claw ; the hind toe and claw.

In taking the extreme length my rule has always been to measure from the tip of the bill, following its curvature, if any, to the end of the tail. The advantage of this plan is that by deducting the measurements of the culmen and the tail, which are given separately, you obtain the exact length of the body. This is only useful, however, for purposes of comparison, because the measurements of a bird stretched at full length do not afford any correct idea of its relative size as a living bird.

Next, as to form and colour. In order to make the description intelligible some knowledge is essential of the names usually applied to the various parts of a bird and to the feathers which cover them. The accompanying diagram (Plate VII.), with the references, will I hope be found useful as an explanatory index to the terms commonly used in describing a bird. The bird selected for the outline is our common Harrier (*Circus gouldi*). The technical terms may be multiplied to almost any extent, but for the sake of simplicity I have indicated those only of which a knowledge is absolutely necessary.

The definition of colours in their endless diversity of tone and shade is perhaps the most difficult part of the task, owing to there being no recognised or commonly received standard of nomenclature. Every naturalist has, to some extent, a standard of his own, and we repeatedly find different terms used by different writers to express the same particular idea of colour and shade. There is less danger of inconvenience or confusion from this cause in a large establishment like the British Museum, or the Natural History Museum at the Jardin des Plantes, where all describers have daily access to certain well-known types, and where, in consequence, there is a common

understanding as to what is intended to be expressed by such stock terms as "ashy," "dusky," "cinereous," "rufous," "fulvous," "olivaceous," and the like. But the flexibility of our language enables a describer, by the exercise of a little skill and judgment, and the free use of qualifying adjectives, to express with precision almost every shade of colour by the use of such compound words as "clear brownish-grey," "delicate purplish-grey," etc., with the help also of the comparative term, as for example, "darker towards the base," or "lighter towards the tip." A good deal of practice, however, in describing colours and their distribution is necessary to make an expert in the art, so that a written description may have the effect of bringing the object described vividly and distinctly before the mental eye. Werner's Nomenclature of Colours, although a work very little known or used, I have found very useful for fixing in my own mind certain general rules, so as to ensure consistency in my descriptions of birds and other natural objects.

References to Diagram—Plate VII.

1, forehead (*frons*); 2, crown (*vertex*); 3, hind-head (*occiput*); 4, nape (*nucha*); 5, lore, or loral space; 6, eye (coloured margin, *iris*); 7, ear-coverts; 8, hind-neck (*cervix*); 9, side of neck; 10, back (*dorsum*); 11, rump (*uropygium*); 12, upper tail-coverts; 13, tail-feathers (*rectrices*); 14, primaries, and 15 secondaries (*remiges*); 16, larger wing-coverts; 17, lesser wing-coverts (including "median"); 18, carpal flexure, or bend of wing; 19, scapulars; 20, chin (*mentum*); 21, throat (*gula*); 22, foreneck (*jugulum*); 23, breast (*pectus*); 24, abdomen; 25, vent; 26, under tail-coverts; 27, tibial plumes; 28, cere; 29, ridge of upper mandible (*culmen*); 30, lower mandible.

In continuation of former papers, and as a further contribution to the subject I have been discussing, I beg to lay before the Society the following notes and observations, based chiefly on the examination of recent additions to the collection of birds in the Canterbury Museum:—

Sceloglaux albifacies, *Gray.*—Laughing Owl.

Since the publication of my work several specimens of this bird have been received at the Canterbury Museum. Two of these have the sides of the face sufficiently white to justify the specific name selected by Mr. G. R. Gray, and to which exception has been taken by one of your contributors, who proposes to substitute *ejulans*. (Trans. N. Z. Inst., Vol. III., p. 63.) It cannot be too strongly enforced that a name once imposed is sacred, and must on no account be ignored on the ground of inappropriateness. Classical defects in specific names may of course be corrected, but to disregard the inflexible law of priority, or to make its observation capricious, would lead to endless complications and confusion in our nomenclature. An appropriate and euphonious

Diagram of Bird.
To accompany Paper by Dr. Buller.

CIRCUS GOULDI of New Zealand
3/8 nat. size.

W. L. Buller, del.

name is always to be preferred, but to reject a specific title simply on the score of bad taste is about as unreasonable as to refuse the inherited surname of Redhead to a dark-haired man, or Bluebeard to another wanting this adornment.

It may be objected to the very common practice of associating the names of discoverers and others with new species that this fails to convey any correct impression of the objects themselves; nevertheless this is found to be a most effective mode of honouring those who have benefitted science by their exertions or researches without involving any practical inconvenience in systematic nomenclature.

As a general rule, however, there can be no doubt that in selecting a specific name it is better to fix upon some characteristic feature by which the species may be readily distinguished from other related forms, or from members of the same group.

SPILOGLAUX NOVÆ-ZEALANDIÆ, *Gmelin.*—Morepork.

Judge Munro informs me that some years ago on opening a bird of this species he found in its stomach a specimen of the Weta-punga, or tree-cricket (*Hemideina heteracantha*), with a body as large as a magnum-bonum plum.

A nestling of this Owl obtained in Westland (and apparently a fortnight old) is covered with thick, fluffy down, of a sooty-brown colour, with loose white filaments; inclined to tawny on the under parts, and whiter on the sides of the head and neck; the bill dark brown, with a whitish ridge; legs and feet yellow.

STRINGOPS HABROPTILUS, *Gray.*—Ground Parrot.

Of this species there is a beautifully marked variety in Mr James Brogden's fine collection of New Zealand birds. The whole of the plumage is largely suffused with yellow, especially on the under parts, where each feather has a broad irregular central spot of pale yellow, edged with dusky brown; towards the tips the feathers are greenish-yellow. The upper parts are bright green, prettily rayed with black, and varied more or less obscurely with yellow, the feathers of the nape and sides of the neck having spear-head points of bright yellow near the tips. The tail is conspicuously marked at regular intervals with vandyked bars of clear lemon yellow, getting darker towards the tips; these yellow markings are edged with black, and the interspaces are yellowish-brown, more or less freckled and marbled with black. The primaries and secondaries are similarly marked on their outer webs, but the yellow is not quite so clear.

NESTOR MERIDIONALIS, *Gmelin.*—Kaka.

The tail-feathers of a *Nestor* noticed by Mr. Potts (Trans. N. Z. Inst., Vol. VI., p. 148), and now in the Canterbury Museum, belong evidently to a

highly-coloured variety of the common species, for they correspond in their style of colouring with the tail-feathers of *var. d*, described at page 43 of my Birds of New Zealand, the type of which is in the Colonial Museum at Wellington.

In my Essay on the Ornithology of New Zealand (1865) I recorded a living example of *Nestor meridionalis* in the possession of the Upper Wanganui tribes, in which the overgrown mandibles entirely crossed each other. This bird had been in captivity for some twenty years, and having been fed on soft food the bill was deprived of the wear and tear incident to a state of nature, which would account for its abnormal growth. A wild specimen, however, lately obtained by Mr. Lambert, at Akaroa, presents the same feature, and in an exaggerated degree, both mandibles being quite deformed.

PLATYCERCUS ALPINUS, *Buller.*—Orange-fronted Parrakeet.

This has proved to be a good species, and there are now living examples in the Zoological Gardens, Regent's Park. It is easily distinguished from *Platycercus auriceps*, not only by its paler plumage and orange forehead, but also by its appreciably smaller size. The type specimens of the three species in the Canterbury Museum present the following gradations in size :—

	P. novæ-zealandiæ.	*P. auriceps.*	*P. alpinus.*
Extreme length*	12 inches	10.5 inches	9 inches
Wing from flexure	5·5 „	4·6 „	4·2 „
Tail	6 „	5 „	4·5 „
Culmen	.75 „	·6 „	·5 „
Tarsus	·75 „	·6 „	·5 „
Longer foretoe	1·1 „	1 „	·85 „
Longer hindtoe and claw ...	1 „	·9 „	·75 „

The accompanying sketch (Plate VIII.), in which figures are given of the heads, will show at a glance the amount of difference in this respect between the three birds.

I have in my possession a cluster of eggs taken from the ovary of an adult *P. alpinus.*

PLATYCERCUS AURICEPS, *Kuhl.*—Yellow-fronted Parrakeet.

The small red-fronted Parrakeet, supposed by Mr. Bills to be a new species, is nothing but a variety of *Platycercus auriceps*, with the yellow vertex deeply stained, or rather mixed with red. Mr. Bills states that he found three of these among 600 specimens taken, and one of these marked "male" is in the Canterbury Museum.

EUDYNAMIS TAITENSIS, *Sparrm.*—Long-tailed Cuckoo.

The egg in the Canterbury Museum ascribed (with doubt) to the above

* From tip of upper mandible to end of tail.

species corresponds with a specimen given to me by the Rev. R. Taylor many years ago, and declared by the Maoris to belong to this bird. This specimen was afterwards presented by me to the Colonial Museum at Wellington, and a description of it may be found at page 76 of the Birds of New Zealand.

Anthornis melanura, *Sparrm.*—Bell-bird.

On the 10th October a partial albino was brought to the Canterbury Museum, and I had an opportunity of examining it in the flesh. Although I have seen probably some thousands of this species, this is the only instance I can remember of any departure from the normal colour, unless it be an occasional very slight tendency to melanism.

It is a fine male bird, with the body plumage as in ordinary specimens, but having the whole of the quills and tail-feathers ashy white, the edges of the outer webs slightly tinged with yellow. The shafts of the quills are dark brown, those of the tail-feathers white in their greater portion, becoming brown towards the base. The bastard quills and tertiary coverts are ashy white; the large secondary coverts dark grey tipped with whitish and margined with dull olive; the axillary tufts, lower part of abdomen, flanks and under tail-coverts pale lemon yellow. Irides, bill, and feet as in ordinary specimens.

There is a fine living example of this bird (an adult male) in the aviary of the Zoological Society of London. It shares a large cage with several foreign birds at the further end of the Parrot-house, and seems perfectly happy in its new home. It is incessantly on the move, springing upwards from its perch and turning a half somersault in the air, but I never heard it utter a sound. The deafening screams of the macaws and other parrots in its neighbourhood may have something to do with this. It seems strange that a bird which it is almost impossible to cage successfully in its native country should have found its way, by accident as it were, into the "Gardens" on the other side of the world. The curator informed me that he had purchased it for a mere trifle from a seaman at one of the London docks.

Further inquiries have only tended to confirm my belief that the present scarcity of this and some other other species in the North Island is due to the ravages of the introduced rat (*Mus decumanus*), which now swarms throughout the country and will continue probably to increase. F. von Fischer calculates that a single pair of these rats might have, after ten years, a progeny of 48,319,698,843,030,344,720 individuals (Zool. Gard., 1872, p. 125.)

Orthonyx ochrocephala, *Gray and Mitch.*—Yellow-head.

Writing of *Orthonyx albicilla*, in 1871,* Mr Potts says that "its habits so closely resemble those of *Mohoua ochrocephala*, that one sees with regret that ornithologists have lately seen fit to class it with another group." In his last

* Trans. N. Z. Institute, III., p. 74.

paper,* however, he states that "closer observation induces the belief that this species may be separated from *O. ochrocephala* in order to place it near to *Certhiparus novæ-zealandiæ.*" It is to be regretted that he does not favour us with some particulars of this closer observation. For my own part, although I have studied the living birds pretty closely, I can see no valid reason for disturbing the accepted generic relations. On referring to the accompanying sketch (Plate VIII.), and comparing figs. 8 and 12 with figs. 9 and 14, it will be seen that *O. ochrocephala* and *O. albicilla* come very near to each other in the characters there indicated. Figs. 11 and 15 represent the wing and foot of *O. ochrocephala.* It will be found on comparison that the wing feathers present the same arrangement in *O. albicilla*, and that the foot, although more slender, has the same generic character. The sternum is precisely alike in both species. The peculiar feature of a black mouth is common to both; their style of song is the same; the sexes are alike in both, and their habits of nidification are very similar. It is true that there is some difference in the colouration of their eggs, but this is of no generic importance, inasmuch as the form is the same in both. The spiny character of the tail-feathers is less pronounced in *Orthonyx albicilla* than in *O. ochrocephala*, but it will be found that this is produced by the wearing away of the webs from the end of the shaft, instead of being congenital as in the typical *Orthonyx.*† Indeed the New Zealand form is so aberrant that it becomes a question whether it ought properly to be referred to that genus. If it should be decided to separate it, we must, I suppose, reinstate Mons. Lesson's somewhat inappropriate appellation of *Mohoua* to distinguish the genus.

On comparing figs. 10 and 13 with those enumerated above, it will be seen that *Certhiparus novæ-zealandiæ* belongs to a sufficiently distinct genus.

Myiomoira macrocephala, *Gmelin.*—Yellow-breasted Tit.

A very pretty albino specimen, received from Otago, has nearly the whole of the body white, with a wash of bright yellow on the head, breast, and abdomen; on the fore part of the breast there is a broad mark of velvety black, and on the upper surface there are a few scattered feathers of the same; some of the wing-feathers are pure white, the rest are black; the two middle

* Trans. N.Z. Inst., VI., p. 144.

† Orthonyx, *Temm.*—Bill rather short and nearly straight, with the culmen elevated at base, and curved to the tip, which is slightly emarginated; the sides compressed, and the lateral margins slightly curved; the gonys moderate and ascending; the gape furnished with weak bristles; the nostrils basal, and placed in a broad groove, partly closed by a membrane, leaving the opening exposed. Wings short and rounded, with the fourth quill nearly as long as the fifth and sixth, which are equal and longest. Tail long and broad, with the shaft of each feather prolonged beyond the web, and rather strong. Tarsi strong, longer than the middle toe, and covered in front with broad scales. Toes moderate and strong; with the outer toe nearly as long as the middle one, and united at the base; the hind toe long and strong; the claws long, very strong, compressed and acute.

tail-feathers are white, the outer ones black, obliquely crossed with a bar of white; bill and legs as in ordinary specimens.

Miro traversi, *Buller.*—Chatham Island Tit.

Several further specimens have been obtained of this very interesting form, which appears to be strictly confined to the Chatham Islands. They differ in no respect from those already described.

Sphenœacus rufescens, *Buller.*—Chatham Island Utick.

Referring to the argument as to the distinctness of this species (Trans. N.Z. I., Vol. VI., p. 116), I may mention that before leaving England I sent across to Bremen for examination and comparison with *S. punctatus* two fine examples (male and female) received from Mr. Henry Travers, and that Dr. Finsch, on returning them, informed me he was now quite convinced of the validity of this species. These specimens came from the Chatham Islands, and are now in the British Museum.

Sphenœacus fulvus, *Gray.*

No further specimens of this somewhat doubtful species have been obtained.

Creadion carunculatus, *Gmelin.*—Saddle-back.

In the Natural History Museum of the Jardin des Plantes in Paris, I observed an adult specimen of *Creadion carunculatus* in partial albino plumage. There are two others in the immature plumage, one of these being very strongly tinged all over with ferruginous. In the Canterbury Museum there is an example (adult) with a single white feather on the breast, and another bird, in young plumage, has the caruncles so reduced as to be scarcely visible.

Carpophaga novæ-zealandiæ, *Gmelin.*—Kereru.

I think it will be found necessary to remove our Wood-pigeon from the genus *Carpophaga* to that of *Columba.* I am forwarding a specimen in spirits to Mr. Garrod, the able Prosector to the Zoological Society, who has kindly undertaken to report on its anatomical and structural affinities.

Ocydromus australis, *Sparrm.*—South Island Weka.

There are two very handsome albinos of this species (from Canterbury) living in the Zoological Society's Gardens, Regent's Park. The plumage is entirely ashy white, with obsolete spots and markings of pale grey; the irides, bill and feet very brightly coloured. There is a slight difference in size, but otherwise the two birds are almost precisely alike. I understand that they were captured at the Four Peaks Station, and sent home by the Christchurch Acclimatization Society.

I have seen an example of this bird in pied plumage, similar to the partial

albino of *Ocydromus earli*, mentioned at page 166 of the Birds of New Zealand, that is to say, with straggling pure white feathers all over the body.

Ocydromus fuscus, *Du Bus.*—Kelp-hen.

In young birds the primaries are obscurely banded with rufous. These markings disappear after the first or second moult, and the rufous streaks on the upper surface appear to diminish as the bird gets older.

Ortygometra affinis, *Gray.*—Water Crake.

The bands on the flanks are more conspicuous in the male, and the ferruginous of the upper parts is brighter; in other respects the sexes are alike. There is no appreciable difference in size.

Recurvirostra novæ-hollandiæ, *Vieill.*—Red-necked Avocet.

The sexes are exactly alike. The young of the first year has the black of the upper surface deeply tinged with brown; across the shoulders, when the wings are closed, there is a horse-shoe mark of blackish grey; head and neck pale ashy brown, darker on the throat, and inclining to rufous on the nape and sides of the neck.

Thinornis novæ-zealandiæ, *Gmelin.*—Sand Plover.

Dr. Dieffenbach states in his report to the New Zealand Company (Parl. Pap., 1844) that he found this species inhabiting the strand at Port Nicholson in 1840, and he gives an accurate description of it. It is singular that it has not since been met with in the Wellington province.

Ardea sacra, *Gmelin.*—Blue Heron.

In the young of the first year the plumage is largely stained with brown, especially on the upper parts; all the wing-coverts are shaded with brown towards the tip, with a narrow terminal edging of a lighter tint.

Ardetta maculata, *Latham.*—Little Bittern.

The Canterbury Museum now contains four specimens of this little Bittern, all obtained on the West Coast. Two of these are marked "male," and the others "female." One male and one female are in the plumage of my "adult male," the other male and female are in the plumage of my "young male." (Birds of N.Z., pp. 235-236.) If the sexing in these cases is to be relied on it would seem that, in our New Zealand bird, the sexes are alike, the plain tawny wing-coverts being only a sign of immaturity. As already mentioned (l.c., p. 236) my "young male" presented indications of a change of plumage. See remarks in last volume of Transactions N.Z. Inst., pp. 119-121.

Tringa canutus, *Linn.*—Knot.

Dr. Finsch expresses his belief that the bird occurring in New Zealand will turn out to be *Tringa crassirostris*, Temm. and Schleg., the larger eastern representative of *T. canutus*. I was not able to take a specimen to

England with me, and have had no opportunity of comparing the two species. The following are the measurements of a fine specimen (in full summer plumage) obtained at the Ninety-mile Beach on the 2nd April.

Length	9	inches.
Wing from flexure	6·4	,,
Tail	2·25	,,
Bill, along the ridge	1·15	,,
Bare tibia	·55	,,
Tarsus	1·15	,,
Middle-toe and claw	1·15	,,
Hallux and claw	·25	,,

LIMOSA BAUERI, *Naum.*—New Zealand Godwit.

I have mentioned in the Birds of New Zealand that the length of the bill in this species is very variable. In an individual lately examined the bill measures 4·6 inches, although the wing is only 9·5, and the tarsus 2·4.

LIMNOCINCLUS ACUMINATUS, *Horsf.*

This is a recent addition to our fauna, and several specimens of both sexes have been obtained on the shores of Lake Ellesmere.

In the fifth volume of Transactions (page 198) it is incorrectly called "*Limnocinclus australis*, Gray." The synonymy stands thus :—

> *Limnocinclus acuminatus*, Horsf.; Jard. and Selb. I. O., pl. 91, Gould, B. A. VI., pl. 30=*L. australis*, Jard. and Selb.=*L. rufescens*, Midd.

SPATULA VARIEGATA, *Gould.*—Spoon-bill Duck.

The nestling of this duck is covered with thick down, with long produced filaments on the upper parts of the body. The downy feathers composing the tail are rather long and have broad spreading plumelets. The upper surface is bright olive-brown ; a broad stripe over the eye, another less distinct immediately below the eye, a conspicuous spot on each side of the back behind the wings, and another on each side of the rump fulvous yellow ; the whole of the under surface fulvous yellow, shading into brownish-olive on the sides of the body and on the breast. Bill brown, with a yellow nail.

FULIGULA NOVÆ-ZEALANDIÆ, *Gmelin.*—New Zealand Scaup.

There is a smaller form in the Canterbury Museum, several of which were obtained at Lake Ellesmere. It is of a more chestnut hue than ordinary specimens of this duck, but on a careful comparison I can find nothing to distinguish it from the above species.

STERCORARIUS PARASITICUS, *Linn.*—Buffon's Skua.

Dr. Finsch expresses his belief that the New Zealand specimen of this bird (still unique) which I forwarded to him for examination, is referable to

Lestris longicaudatus. (Trans. N. Z. Institute, Vol. V., p. 209). Mr Sharpe and myself went very carefully into the matter, and examined all the specimens in the British Museum. We came to the conclusion that *L. longicaudatus*, Degl., *L. buffoni*, Boie, and *Stercorarius cephus*, Gray, were all referable to the above species. The full synonymy will be found at page 268 of the Birds of New Zealand.

PROCELLARIA PARKINSONI, *Gray.*—Black Petrel.

The young is covered with sooty down, which adheres to the plumage for a considerable time, as in other petrels, imparting to the body an appearance of unnatural size. It comes off first from the head, breast, and upper surface; and in this operation the bird itself no doubt assists.

PRION BANKSII, *Gould.*—Banks' Dove-petrel.

A further investigation of the subject has satisfied me of the propriety of retaining this species. Apart from the slight differences of colour, *P. banksii* has the tail longer and more conical, the wing decidedly longer, and the bill appreciably broader at the base than in *P. turtur*; besides which the unguis or hooked extremity has a very different form. This will be at once apparent on reference to figs. 3 and 4 (Plate VIII). *Prion vittatus* is readily distinguished from the other species by the greater expansion of its bill, and the conspicuous pectination along its edges. (Figs. 1 and 2.)

The young are covered with slaty-grey down.

PUFFINUS TRISTIS, *Forster.*—Shearwater.

On the last occasion of my coming through the French Pass (Sept. 27), I observed a flock of these birds numbering about 200. They flew in a compact body, fluttering near the water and occasionally resting upon it, keeping so close together as quite to darken the surface. A few terns (*Sterna frontalis*) were mingling with the flock.

The young of this species is covered with thick sooty-grey down, which is not cast off till the feathers beneath are fully developed. The fledgling has certainly the appearance of being larger than the parent bird. This is not due, however, to its excessive fatness, as Mr. Potts supposes*, but to the circumstance that at the end of the true plumage there are downy filaments, about an inch long, matted closely together, and forming a warm outer covering for the body. A thick tuft of down, about 2 inches in length, represents the tail.

PHALACROCORAX PUNCTATUS, *Sparrm.*—Spotted Shag.

The examination of a large series of specimens has satisfied me that the bird figured in the Birds of New Zealand is the *young* and not the adult female, but the loral membrane should have been coloured orange instead of

* Trans. N. Z. Inst., V., p. 200.

W. L. Buller, del.

blue. The plumage of the adult is exactly the same in both sexes. The vertical and occipital crests are present all through the year, but as the breeding season approaches they become larger and more conspicuous, while the hind-neck and the flanks are profusely ornamented with loose white plumes three quarters of an inch in length.

In the very young bird the skin is entirely bare, nothing being visible but the roots of the downy plumelets. When more advanced the body is covered with thick down, dark ash-grey on the upper surface and white on the under parts; the forehead, fore part of crown, and a portion of the face and throat perfectly bare.

Phalacrocorax novæ-hollandiæ, *Steph.*—Black Shag.

Among birds of this class it is a rare thing to find any conspicuous departure from the ordinary plumage. The following is the description of a fine albino obtained at Sumner, near Christchurch:—General upper surface dark cream colour; the crown, hindneck, lower part of back and flanks stained and shaded with brown; the scapulars and wing-coverts broadly margined with yellowish brown; sides of the head, throat, foreneck, and all the under parts pure white; the wing-feathers are yellowish white, more or less clouded and freckled with brown; the old tail-feathers are yellowish white, the new ones ashy; and interspersed with the plumage of the upper parts there are numerous new feathers of a brownish-ash colour with darker edges, thus indicating a transition to a darker state of plumage. The bare facial membrane is flesh-coloured, with an obsolete yellow spot in front of the eye; bill black; legs and feet dark brown.

The young of this species attains to a considerable size before the downy covering makes its appearance.

Phalacrocorax brevirostris, *Gould.*—White-throated Shag.

The nestling is covered with thick down of a jet black colour; forehead and fore part of crown and a broad space round the eyes and across the chin perfectly bare and of a pale blue, changing to purplish flesh colour towards the base of lower mandible. The feathers come first on the back and flanks, the quills and tail-feathers also making an early appearance.

In some examples of this bird there is a tendency in the under parts to change to white, and as a rule the extent of white on the throat and foreneck is uncertain and variable. On this account Dr. Finsch seems inclined to unite the species with *P. melanoleucus* (Trans. N. Z. Inst., V., p. 211). But I have never seen a specimen exhibiting the "frill" or lateral and occipital crests which are characteristic of the last named species.

Phalacrocorax carunculatus, *Gmelin.*—Rough-faced Shag.

The sexes, as determined by Mr. Henry Travers, are exactly alike, both as to size and plumage.

Eudyptes antipodum, *Homb. and Jacq.*—Yellow-crowned Penguin.

The specimen mentioned at page 346 of the Birds of New Zealand, as being in the Otago Museum, has found its way by exchange into the collection of the Canterbury Museum. On examining it more closely, and comparing its proportions with those given in my work (from a British Museum example), I observe a remarkable difference in the size, which may possibly prove of specific value. The colours of the plumage are those of *E. antipodum*, although somewhat duller; but the lengthening of the coronal feathers is scarcely perceptible. Judging from the worn and blunted condition of the claws, the bird is an adult. The comparative measurements are as follows:—

	Brit. Mus. Spec.	Cant. Mus. Spec.
Total length	32 inches	26·5 inches
Length of flippers	7·5 „	7·25 „
Tail	3 „	1·5 „
Bill, along the ridge ...	2·5 „	2 „
Bill, along edge of lower mandible	3 „	2·75 „
Tarsus	1·5 „	1 „
Middle toe and claw ...	3·5 „	3 „

Eudyptula undina, *Gould.*—Little Penguin.

The young is covered with sooty-brown down, inclining to grey on the throat and foreneck, whitish on the breast and abdomen. As the bird gets older the down on the upper parts becomes lighter; and it ultimately comes off in patches, exposing tracts of young feathers, growing very close together and assuming from the first the colours of the adult.

Eudyptula minor, *Gmelin.*—Blue Penguin.

In a communication to the Zoological Society some time since, Dr. Finsch described* what he took to be a new species of penguin from New Zealand, resembling *Eudyptula minor* in plumage, but somewhat larger in all its proportions. The specimen in question was forwarded to him by Dr. Haast, and on inquiry here I find that it differed in no respect from other examples of the true *E. minor* in the Canterbury Museum. As Dr. Finsch had hitherto refused to recognize more than one species of *Eudyptula* in New Zealand, I conclude that the bird with which he compared his supposed new species was in reality our smaller form, *Eudyptula undina*, and not *E. minor*.

Apteryx australis, *Shaw.*—South Island Kiwi.

In the Canterbury Museum there is a partial albino, in which the crown and sides of the head, the throat, the whole of the foreneck and the front of the thighs are yellowish white; whiskers black, and the rest of the plumage as in ordinary specimens.

* *Eudyptula albosignata*, Finsch, P.Z.S., 1874.

Apteryx haasti, *Potts.*—Large Grey Kiwi.

Since the publication of my Birds of New Zealand, another specimen has been received at the Canterbury Museum. This bird differs from those previously described in being somewhat darker, and more strongly suffused with chestnut.

I am informed that Mr. Bills lately obtained from the West Coast and forwarded to England five specimens of *Apteryx haasti*, some of which were larger and more handsomely marked than those in the Museum. These were probably females, although the collector was unable to state the sex.

References to Plate VIII.

Figs. 1 and 2. Prion vittatus. 3. Pr. turtur. 4. Pr. banksii.
Fig. 5. Platycercus novæ-zealandiæ. 6. Pl. auriceps. 7. Pl. alpinus.
Figs. 8, 11, 12, and 15. Orthonyx ochrocephala.
Figs. 9 and 14. Orthonyx albicilla.
Figs. 10 and 13. Certhiparus novæ-zealandiæ.

Art. XXIII.—*Notes on certain disputed Species of New Zealand Birds.*

By Walter L. Buller, D.Sc., F.L.S., C.M.Z.S., etc.

[*Read before the Wellington Philosophical Society, 12th September*, 1874.*]

A small collection of New Zealand birds forwarded to Bremen by the authorities at the Colonial Museum for Dr. Finsch's examination has lately been sent over to London, and I have carefully repacked the skins for transmission to the colony. As each bird bears a memorandum in Dr. Finsch's handwriting giving the conclusion arrived at after an actual examination and comparison of specimens, and as several months must necessarily elapse before the specimens themselves can reach Wellington, I beg to summarize the results for the information of the Society.

The collection contains one specimen of the handsomely marked Woodhen from the South Island, named by Captain Hutton *Ocydromus hectori*. Dr. Finsch is of opinion that this is a good and valid species. (See my remarks under the head of *Varieties*, Birds of New Zealand, p. 171.)

Captain Hutton is less fortunate, however, with his *Graucalus concinnus* from Invercargill. Dr. Finsch says this is "undoubtedly the young of *G. parvirostris*, Gould," and adds "no doubt nothing else than a straggler from

* Dated at London, 10th July, 1874.—Ed.

Tasmania." In other words, *Colluricincla concinna*, Hutton = *Graucalus concinnus*, Hutton = *Graucalus parvirostris*, Gould.

Dr. Finsch, after examining the specimen of the so-called *Myiomoira dieffenbachii*, writes, "this orange-breasted form is the true *macrocephala*," thus confirming the view advanced by me in 'Birds of New Zealand,' p. 126. On another disputed point also I find that I have Dr. Finsch's support. In the 'Ibis' controversy between Captain Hutton and myself, reprinted in last year's Transactions of the N. Z. Institute, pp. 126-138, my opponent argued that my specimens of *Xenicus longipes* in the Colonial Museum had been "wrongly determined," while I, on the other hand, contended that *Xenicus stokesii* had no real existence as a species. The specimen labelled by Captain Hutton as "*Xenicus stokesii*, female," and sent forward to Dr. Finsch, is referred by this naturalist, without hesitation, to *X. longipes*, Gmelin.

Captain Hutton's *Chrysococcyx plagosus*, from the Chatham Islands, (Trans. N. Z. Institute, Vol. V., p. 223), which I declined to admit into my work as a distinct species, is also rejected by Dr. Finsch, who refers the specimen sent to *C. lucidus*. The synonymy (*auct.* Finsch) stands thus:—*Lamprococcyx plagosus*, Gould (Handbook I., p. 623) = *Chrysococcyx nitens*, Forster = *C. lucidus*, Gml.

The opinion expressed by me (Trans. N. Z. Institute, Vol. I., p. 111) that *Anthochæra bulleri* was identical with *A. carunculata* of Australia, is confirmed by Dr. Finsch's examination of the type specimen. Having good reason to doubt whether the specimen in question (originally from the Auckland Museum) was actually killed in New Zealand, as alleged, I expunged the species in my last published list of New Zealand birds.

The example of *Totanus canescens* (sent by Mr. Purdie, of the Otago Museum), Dr. Finsch observes "agrees very well with European specimens."

The late Mr. D. Monro's specimen of *Hydrochelidon leucoptera*, from Marlborough, was rightly determined.

The Petrel referred by Captain Hutton and myself to *Puffinus brevicaudus* is identified by Dr. Finsch as *P. tenuirostris*, Temm.

Prion banksii, Hutton (*nec* Smith) = *Prion turtur*, Banks and Gould.

Eudyptes antipodum, from the Otago Museum, is correctly identified.

Dr. Finsch considers the crested Grebe with the dark breast only a variety of the well-known *Podiceps cristatus*. (See my remarks on this form, Birds of New Zealand, p. 354.)

ART. XXIV.—*On the Existence of two Species of* Hieracidea *in New Zealand.*

By WALTER L. BULLER, D.Sc., F.L.S., F.G.S.

Plate IX.

[*Read before the Philosophical Institute of Canterbury, 28th October,* 1874.]

As ornithologists are still divided in opinion as to the propriety of separating our *Hieracidea ferox** as a species from *H. novæ-zealandiæ*, I am anxious to lay before the Society some further evidence in support of my present view that these birds are distinct.

Among Hawks generally—and the genus *Hieracidea* is no exception to the rule—the female is both larger and more handsomely marked than the male. Such being the case, let us for our present argument compare an adult female of *Hieracidea novæ-zealandiæ* with an adult female of *H. ferox.* This will afford us the fairest mode of determining their relative size, and the best means of ascertaining any differences in the plumage of the two species.

For this purpose I shall lay before the meeting two specimens selected from the type collection in the Canterbury Museum. The larger of these birds was obtained at Castle Hill, and the other on the Bealey—well known localities within this province—and both individuals proved on dissection to be females. The following is a comparative statement of their measurements :—

	H. novæ-zealandiæ.	*H. ferox.*
Extreme length	19·5 inches	16 inches
Wing from flexure	12 „	10·5 „
Tail	8·5 „	7·75 „
Culmen (from cere to tip) ...	1 „	·8 „
Tarsus	2·5 „	2·2 „
Middle toe and claw	2·8 „	2·25 „
Hind toe and claw	1·85 „	1·35 „

It will be seen from this that *Hieracidea novæ-zealandiæ* is a considerably larger bird than *H. ferox.* It has a proportionately powerful bill, while its legs and feet are decidedly more robust. In the colours and markings of the plumage there is a general similarity between them; but on a close comparison of the two examples exhibited it will be seen that *H. novæ-zealandiæ* has the bars on the upper surface far more distinct and numerous besides being of a brighter rufous, the tail-coverts are more conspicuously marked, the bars on the tail are broader and whiter, and there is a larger amount of white on the throat, breast, and abdomen. In the present example of *H. ferox* the breast is much darker than in the other bird, the middle portion of each feather being occupied by a broad lanceolate mark of blackish

* *H. ferox,* Peale=*H. brunnea.* (*Vide* Trans. N. Z. Inst., Vol. VI., p. 113).

brown, and there is less of the buff and rufous stains which impart so warm an effect to the breast of *H. novæ-zealandiæ.* There are other minute points of difference, but these may be mere individual peculiarities. Enough has, however, been pointed out to show that the two species may be readily distinguished from each other; and this is the only point at issue.

Of course the whole value of this evidence depends on the accuracy of the "sexing" in each case. I think this, however, is placed beyond all doubt, for the larger bird was determined by Mr. J. D. Enys, who collected it, while the smaller one was received at the Museum in the flesh, and was dissected by the taxidermist for the express purpose of ascertaining the sex. Mr. Fuller assures me that he was most careful in his examination, and that the specimen exhibited is to an absolute certainty a female.

In his last paper on the Birds of New Zealand (Trans. N. Z. Inst., Vol. VI., pp. 139-152) Mr. Potts enters upon this question, and in doing so takes occasion to contrast what I said in 1868 with what I said on the same subject in 1872. His argument is somewhat obscure; but if he simply means that I am open to conviction where I find myself wrong, I readily concede the point. But the inconsistency to which he directs attention is more apparent than real. *Hieracidea brunnea* Gould (=*H. ferox*, Peale) was originally described from an immature bird. The observations recorded in my early paper have at any rate proved useful as evidence that the plumage of the young is alike in both species. However, I am glad to find so good an observer as Mr. Potts in favour of there being two species, because it tends to confirm my present belief.

Art. XXV.—*Notes on an alleged new Species of Tern* (Sterna alba, *Potts*).

By Walter L. Buller, D.Sc., F.L.S., C.M.Z.S.

[*Read before the Philosophical Institute of Canterbury, 1st October,* 1874.]

Mr. Potts, in his notes on the birds of New Zealand read before the Philosophical Institute of Canterbury in December last (Trans. N.Z. Inst., Vol. VI., pp. 139-153), takes exception in the following terms to my treatment of his supposed new species of Tern, (*Sterna alba*) :—

"The white Tern seen by the writer on the Ashburton, and described by him in Trans. N. Z. Inst., Vol. III., is quietly placed by Dr. Buller with *S. nereis,* to which he gives the name of the Little White Tern. This fine white Tern was seen on the Waitangi River by the Hon. G. Buckley and others. Last month (20th November) a pair were seen flying up and down the course of that great river."

W. L. Buller, del. Figs. 1.3.& 4. HIERACIDEA NOVÆ ZEALANDIÆ. Figs. 2.& 5. H. FEROX.

On a careful reperusal of Mr. Potts' published notes I acknowledge that I was wrong in referring his bird to *Sterna nereis*, but until a specimen has been actually obtained and examined it is impossible to admit it into our list as a recognized species. Mr. Potts, in his original notice (*t.c.*, p. 107), merely described the bird as it appeared to him on the wing. He stated that the whole plumage was white, and that "the bill appeared to be light-coloured," adding that these "observations were made during its rapid movements." He gave no hint whatever of its size, although he now refers to it as a "*fine* white Tern," as compared with the Little White Tern (*Sterna nereis*).

On such a description as this I fear that Mr. Potts' claim to the discovery of a new species would scarcely be admitted by ornithologists at home; and even if it were the name of *Sterna alba* has been preoccupied by Gmelin. The bird may turn out, as Mr. Potts himself suggests, to be identical with a species recorded from Norfolk Island. But if, on further acquaintance, it should prove to be new, I think we cannot do better than associate Mr. Potts' own name with it in lieu of the one he has proposed.

Art. XXVI.—*Description of a new Species of Petrel* (Procellaria affinis). By Walter L. Buller, D.Sc., F.L.S., etc.

[*Read before the Canterbury Philosophical Society, 28th October,* 1874.]

In the Canterbury Museum I find the skin of a Petrel which appears to be new. There is a ticket attached to it with the following memorandum, "Shot—Potts River, 1872," and this is all the information I possess about the specimen. It bears a general resemblance to *Procellaria cookii*, but has longer wings and shorter legs, besides certain differences of plumage which may be due to immaturity.

The type specimen of *P. cookii*, which was obtained off the New Zealand coast, is in the British Museum. In this bird the wing measures from the flexure to the tip 9·25 inches, whereas in the present species, although of similar size, the wing measures 10·5, showing a difference of an inch and a quarter. In *P. cookii* the bare tibia measures half an inch in length; in this species it is scarcely visible. The plumage likewise differs in the following respects. Instead of the whole upper surface of the wings being blackish-brown, the secondaries and their coverts are ashy-grey narrowly margined with white; the feathers of the back and rump and the upper tail-coverts have darker margins; and there is far less white on the inner webs of the secondary quills. The legs and feet, instead of being yellowish brown with paler webs, as in *P. cookii*, are (so far as I can judge from the dried specimen) dull yellow

with the extremities and the webs perfectly black. The present bird differs further in having the breast and abdomen almost entirely ashy-grey, but this colour is passing off, and therefore seems to indicate a comparatively young bird in a transitional state of plumage. The inner surface of the wings is pure white, but there is a broad band of slaty-black extending from the elbow to the carpal flexure where it spreads, and is then continued along the outer edge.

Procellaria affinis. Sp. nov.

Diag.—Supra saturatè cinereus; dorsi plumis et supra-caudalibus nigro terminatis; alarum minimis et alâ spuriâ nigricanti-brunneis; primariis extùs nigricanti-brunneis, intùs albis; secundariis pallidè cinereis, albo angustè marginatis, basaliter albis; rectricibus saturatè cinereis, duabus externis intùs albidis; fronte albâ cinerascenti-nigro variâ; regione suboculari conspicuè cinerascenti-nigrâ; facie laterali guttureque albis; pectore imo et abdomine cinereis plumis basaliter albis; corpore reliquo subtùs albâ, pectoris lateribus cinereo lavatis, hypochondriis et subcaudalibus inferioribus cinereo variis et minutè transfasciatis; subalaribus albis, exterioribus conspicuè nigricantibus: rostro nigro: pedibus sordidè flavis, digito externo et membranis interdigitalis nigris.

Hab.—New Zealand.

Comparative Statement of Measurements.

	P. cookii.	*P. affinis.*
Extreme length	12·5 inches	13 inches
Wing from flexure	9·25 ,,	10·5 ,,
Tail	4 ,,	4 ,,
Culmen (following curvature) ...	1·4 ,,	1·25 ,,
Lower mandible (from the gape)	1·5 ,,	1·5 ,,
Bare tibia	·5 ,,	— ,,
Tarsus	1·2 ,,	1·2 ,,
Middle toe and claw	1·5 ,,	1·75 ,,

In *Procellaria leucoptera* and *P. mollis* again we find very similar plumage; but the former (according to Gould) has the wing 2 inches shorter, although the other proportions are the same; while *Procellaria mollis*, on the other hand, with a decidedly shorter wing than *P. affinis*, has the tail nearly an inch longer. It has, moreover, a larger tarsus.

The four species are closely related to one another, and form together a very natural group or sub-genus.

ART. XXVII.—*On the Occurrence of* Plotus novæ-hollandiæ *in New Zealand.* By WALTER L. BULLER, D.Sc., F.L.S., etc.

[*Read before the Wellington Philosophical Society, 15th October,* 1874.]

THE Canterbury Museum contains a roughly prepared skin of the Australian Darter (*Plotus novæ-hollandiæ*) obtained under circumstances which leave no doubt on my mind of the occurrence of this bird as a straggler in New Zealand.

Mr. F. R. Fuller, the excellent taxidermist attached to the Museum, during a visit to Hokitika in January last, found the skin stretched flat and nailed up inside an old shed. He brought it away, but could get no information as to how it came there. An examination of the skin shows clearly that it was in a fresh state when affixed to the wall, the edges having, in the process of drying, shrunk away from the nails on both sides.

It would seem that some digger or working settler, probably attracted by the rarity of the bird, had adopted this rude mode of preserving it. At any rate the skinning operation appears to have been performed by unskilful hands, an open slit having been made from the hind part of the head right down the back to the root of the tail.

The suggestion will occur that the bird may have come down from Australia in some vessel; but the condition of the tail-feathers, which to the very tips are clean and unbroken, proves, I think, that this was no caged bird. Those who have kept birds of this class in captivity know how soon the tail-feathers in particular get soiled and abraded. The almost entire absence of fat on the inner surface of the skin would seem to indicate that the bird had performed a long journey on the wing; although this may be otherwise accounted for on the supposition of its being a female in breeding condition. The plumage of this specimen, of which a description is given below, allows of its being either an adult female or a young bird of the first year, at which stage the sexes are alike.

I may here mention that Dr. Haast, during his exploration of the Southern Alps in the summer of 1862, met with a bird in the Ohau Lake, swimming very low in the water, which he was unable at the time to identify, and that he is now convinced it was a *Plotus*.

The habitat of *Plotus novæ-hollandiæ*, according to Gould, is confined to the colonies of South Australia and New South Wales, where it is thinly but generally dispersed in all situations suitable to its habits, such as the upper parts of armlets of the sea, the rivers of the interior, extensive water-holes, and deep lagoons. The male differs from the female in having the breast and neck black with an arrow-head mark of white on the throat, and a

broad stripe of the same from the base of the mandibles on each side of the upper neck; also in having rusty red stains on the under side of the throat.

Description of Hokitika Specimen.

Crown, nape, hind part of neck and shoulders blackish-brown, mottled with white, each feather being narrowly edged with it; the whole of the back and rump black; quills and tail-feathers black, the inner webs of the former tinged with purplish brown, and the three innermost secondaries with a broad longitudinal stripe of white on their outer vane; bastard quills and the superior primary coverts black, the inner ones slightly tipped with white; the larger secondary coverts are white on their outer webs and beyond the shaft, then black with a sharply defined edge; the smaller coverts white in their central portion, with a black lanceolate stripe on each web and narrowly margined with white; towards the edge of the wing the feathers are black with a central arrow-head spot of white, becoming entirely greyish white at the carpal flexure; scapulars black with a broad stripe of dull white on their outer webs; the coverts white in their central portion with black shafts, a broad stripe of black on each web with a narrow outer margin of white; throat, foreneck and all the under parts buffy white; under surface of the wings and tail black. A broad line of black extends from the posterior edge of the eyes down the side of the neck, separating the dark brown of the hind neck from the white plumage of the under surface. The middle tail-feathers and the innermost scapulars on the outer webs have a peculiar crimped surface. Bill yellowish horn colour, brownish towards the base of the upper mandible; the inner cutting edges of both mandibles armed with minute sharp barbs inclined backwards. Feet dull yellow, shaded with brown; claws yellowish brown.

Extreme length (approximately)	... ...	40 inches
Wing from flexure	... ...	14 "
Tail (consisting of eight feathers)	... ...	10 "
Culmen	... ...	3·15 "
Bill, along edge of lower mandible	... ...	4·25 "
Tarsus	... ...	2 "
Longest toe and claw	... ...	3·8 "
Hind toe and claw	... ...	1·5 "

Art. XXVIII.—*Notice of a new Species of Parrakeet in New Zealand.*

By Walter L. Buller, D.Sc., F.L.S., etc.

Plate VIII.

[*Read before the Philosophical Institute of Canterbury, 22nd December,* 1874.]

Whilst I was in England superintending the publication of my Birds of New Zealand, Mr. Dawson Rowley of Chichester House, Brighton, forwarded to me for inspection the skin of a Parrakeet, received from the South Island, which, on account of its small size, he took to be a new or hitherto undescribed species. On examination it proved to be only a small example of *Platycercus novæ-zealandiæ*—corresponding in fact with Gray's so-called *Platycercus aucklandicus*—and in returning the specimen to Mr. Rowley I could only express my regret that he was doomed to disappointment.

Since my return to the colony, however, my attention has been directed to a very large series of Parrakeets collected in the Canterbury Province by Mr. F. R. Fuller and his assistants; and, after making due allowance for the great variation in size which members of this genus exhibit, I am unable to come to any other conclusion than that there really does exist another species, having similar plumage to *Platycercus novæ-zealandiæ*, but so much smaller in size as to be even less than some examples of the yellow-fronted Parrakeet (*P. auriceps*).

The following are the measurements of a specimen in the Canterbury Museum :—

Length	9·5	inches
Wing from flexure	4·75	„
Tail	5	„
Bill along the ridge	·55	„
Tarsus	·65	„
Longer fore-toe and claw	1	„
Longer hind-toe and claw	·9	„

A better idea of the relative size may be formed when I state that the bill in this bird holds an intermediate position between figs. 6 and 7, Plate VIII., and that the general proportions of the body bear a corresponding relation thereto.

Mr. Fuller, who has dissected some hundreds of these Parrakeets, informs me that the bones of this small red-fronted species are easily distinguished from those of *Platycercus novæ-zealandiæ*, being decidedly weaker and more slender—resembling, in fact, those of *P. auriceps* and *P. alpinus*.

It may also be mentioned that all the specimens of the supposed new species have come from one part of the country—Canterbury North—and

that although *Platycercus novæ-zealandiæ* is very common in the North Island, none of the very small examples have been recorded there.

It being necessary to find a specific name to distinguish this diminutive form, I have much pleasure in dedicating it to George Dawson Rowley, Esq., F.Z.S., whose name is already in one way associated with the discovery, and whose interest in our local zoology has found expression in a charming little museum of New Zealand rarities, among which the unique specimen of the Moa's egg holds a conspicuous place.

PLATYCERCUS ROWLEYI, *sp. nov.*

Ad.—*P. novæ-zealandiæ* simile sed conspicuè minor: prasinus; occipite ad basin plumarum celaté citrino; genis et corpore subtùs flavicanti-viridibus; pileo antico, maculâ ante-oculari, alterâ supra-auriculari et plumis paucis ad latera uropygii postis puniceis; tectricibus alarum dorso concoloribus; remigibus brunneis, alâ spuriâ latissimè ultramarinâ; primariis extus ad basin ultramarino, versus apicem angustè flavido marginatis; sub-alaribus cyanescenti-viridibus; caudâ suprà læte prasinâ; subtus magis flavicante; maxillâ cyanescenti-albâ versus apicem nigricantè, mandibulâ omninò nigricante: pedibus pallidè brunneis: iride rubrâ.

ART. XXIX.—*On the Genus* Himantopus *in New Zealand.*

By WALTER L. BULLER, D.Sc., F.L.S., etc.

[*Read before the Philosophical Institute of Canterbury, 22nd December,* 1874].

PROBABLY the most puzzling group of birds we have in New Zealand is that of the Stilt Plovers, and my object in submitting the following notes is to make another step towards a better acquaintance with and elucidation of the species.

In the first place it is somewhat remarkable that New Zealand should possess certainly two if not three species of a genus of birds so peculiar that (if we except a small one said to exist on the west coast of Madagascar) each of the great divisions of the globe can only boast of one. Even Australia, teeming as it is with wading birds, is the home of only one species of Stilt (*H. leucocephalus*), which is also common to New Zealand, Ternate, Celebes, and Timor. The existence of a second species in this country (*H. novæ-zealandiæ*) was first recorded by Mr. Gould in 1841. Since that date several other names have been added, and (owing to our imperfect knowledge of the seasonal and transitional states of plumage) the nomenclature has got into a state of confusion. As in all such cases, the only escape from this is a careful

study of the species at all ages and at all seasons of the year, noting the changes of plumage that occur, and tracing their progress from youth to maturity.

The present paper is intended to be a contribution of this sort, but as I have not collected or dissected any of the specimens referred to, it would be manifestly unfair to hold me responsible for the *data*. Particulars of season, sex, etc., I have been compelled to take on trust.

For the purposes of this examination I have had before me forty-three specimens, in different conditions of plumage, belonging to the Canterbury Museum.

There is no difficulty whatever in separating *Himantopus leucocephalus*, which is distinguished from *H. novæ-zealandiæ* in the somewhat similar seasonal plumage by its purer and well defined colours, its smaller bill, and appreciably shorter toes and claws. Of course specimens vary, and in a series like the present we meet with large examples of *H. leucocephalus* and small examples of *H. novæ-zealandiæ*, but the general rule holds good throughout. The young are readily distinguished by the enlargement towards the distal end of the tarsus (a provision for the future lengthening of this bone), which diminishes with the growth of the bird. There are two fledglings in the collection, and as the description of the "young" given in my Birds of New Zealand (p. 203) is taken from a somewhat older bird, I append the following notes :—

H. leucocephalus, juv.—Crown of the head, back, and upper surface of the wings brownish-black, tinged more or less with brown, and many of the feathers being narrowly tipped with greyish-white; hind neck greyish-white, mottled with black in its lower portion; forehead, foreneck, and all the under surface, as well as the rump, white; the whole of the quills black, the inferior primaries and the secondaries narrowly tipped with white; tail-feathers black, edged with fulvous, and white at the base. (Obtained at Rakaia, Nov. 1872. Weight, 6oz.)

Of *Himantopus novæ-zealandiæ* I have given in the Birds of New Zealand (pp. 205-206) descriptions of the summer, winter, and adolescent states of plumage, and under the head of "Remarks" I have referred to the numerous transitional states which have led to so much confusion in regard to this species. The description there given, however, of the *adult in winter*, I wish now to qualify by stating that the uniform dark plumage on the abdomen is by no means a constant character.

First of all, as a result of my present examination, I feel bound to dismiss *Himantopus spicatus*, Potts, as having no claim, whatever, to the rank of a species. The type specimen is now before me, and the distribution of colours

(as may be seen on reference to the published description)* indicates a transitional condition. The extra length of leg (as compared with *H. novæ-zealandiæ*) appears to be rather in the tibia than in the tarsus. Mr. Potts makes the black neck and breast his distinguishing feature, but there is another bird in the collection (a male) in which the tarsus is 4 inches, and the tibia 2 inches—altogether a bird of smaller proportions—in which the distribution of colours is the same, although there is a less extent of black on the breast.

I have already described (*l.c.*, p. 204) the young of this species from two young specimens in the Canterbury Museum, the parentage of which was placed beyond all doubt by Mr. Fuller, who secured at the same time the two old birds in black summer plumage. I may add that these latter are still in the collection; the male is perfectly black, and the female slightly pied.

A more matured example of the young bearing the following label, "Shot in Bottle Lake, Jan. 28, 1872; juv.—female; parent bird black," presents a general resemblance to the young of *Himantopus leucocephalus*, but on a close comparison the following differences are observable:—The crown is lighter, being of an almost uniform ash-grey; there is more greyish-white between the shoulders, and the tail-feathers instead of being black are ashy-white, the outer ones having a broad sub-apical mark of dark-grey; and the axillary plumes, under the wings, instead of being black are pure white; there are fewer light margins on the wing-coverts; and the inferior primaries and the secondaries are more largely tipped with white. Some of these differences, however, may be due to the fact that this is a somewhat older bird. In the other specimens, mentioned above, the axillars are black, as in the young of *H. leucocephalus*.

The collection contains nine perfectly black specimens. Of these eight are males; and, according to the labels, all of them were killed in summer. Out of twelve other specimens more or less pied with white, only three are females, all of these (of both sexes) being also summer birds. The extent of white, however, varies considerably in birds shot at one and the same time, some exhibiting only a few white feathers on the neck and breast, whilst in others the white predominates. This irregularity of plumage may perhaps be accounted for on the supposition that the birds do not undergo the complete change at their first seasonal moult, but at some later period—say in their second or third year.

There are two specimens in the collection which are of more than ordinary interest, because they are quite distinct in appearance from either *H. leucocephalus* or *H. novæ-zealandiæ* in their full plumage, and cannot, so far as I at

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* Trans. N.Z. Inst., Vol. V., p. 198.

present see, be a transitional state of either of those species. One of these, presented to the Museum by the late Dr. Barker, bears the following label:—"Orari, Feb. 16, 1872, male," and appears to be in full adult plumage. The other, which is labelled, "Saltwater Creek, April, 1873, male," is apparently a less matured bird. On observing certain indications of a change from black to white in the latter, I at first supposed that the white head and neck might represent the true winter plumage of *Himantopus novæ-zealandiæ*; but, as directly opposed to this view, Dr. Barker's specimen, which I am disposed to make the type of a new species, was killed towards the end of summer. In this bird the entire head and neck, with the breast and under parts are pure white; rump and upper tail-coverts also white; back, scapulars and upper surface of wings and tails glossy black, the inferior primaries and the secondaries tipped with white; under surface of wings and the axillary plumes black. Total length, 14·25 inches; wing from flexure, 9·25; tail, 3; bill along the ridge, 2·6, along the edge of lower mandible, 2·9; bare tibia, 2·2; tarsus, 3·75; middle toe and claw, 1·5.

In selecting a specific name for this bird I have adopted that of *H. albicollis* because it exactly expresses the feature which distinguishes it from the two others, viz., its having the neck entirely white. The same name was applied to a Stilt Plover by Vieillot, but this has proved to be only a synonym of *H. autumnalis*, and the title is therefore free again.

The series of specimens under consideration is unfortunately very deficient in examples killed in winter, and the examination of the subject therefore has not been as complete or exhaustive as I would wish; but two points at any rate have been gained, namely, the elimination from our list of *Himantopus spicatus* (which proves to be no species at all) and the placing on record of a hitherto undescribed form—the White-necked Stilt—which, so far as our present evidence goes, is a good and valid species. To my mind it is perfectly clear that it is either *H. novæ-zealandiæ*, in the mature winter plumage, hitherto unknown, or it is a distinct species; and if Dr. Barker's specimen is rightly labelled as killed in summer, that fact alone is sufficient to disprove the former assumption. The general results are embodied in the following synopsis:—

1. HIMANTOPUS LEUCOCEPHALUS.

   Himantopus leucocephalus, Gould, P.Z.S., 1837, p. 26.
   Himantopus albus, Ellman, Zoologist, 1861, p. 7,470.
   Himantopus leucocephalus, Buller, Birds of N.Z., 1873, p. 203.

2. HIMANTOPUS NOVÆ-ZEALANDIÆ.

   Himantopus novæ-zealandiæ, Gould, P.Z.S., 1841, p. 8.
   Himantopus melas, Hombr. and Jacq., Ann. Sci. Nat., 1841, p. 320.

Himantopus niger, Ellman, Zool., 1861, p. 7,470.
Himantopus melas, Hutton, Cat. B. of N.Z., 1871, p. 30.
Himantopus novæ-zealandiæ, Buller, Birds of N.Z., 1873, p. 205.
Himantopus spicatus (*? picatus*), Potts, Trans. N.Z. Inst., 1872, p. 171, *et.* p. 198.

3. Himantopus albicollis, *sp. nov.*

Ad.—Capite toto cum collo undique et corpore subtùs toto albis; interscapulio, scapularibus cum dorso summo et tectricibus alarum nigris; remiges angustè albido terminatis; subalaribus nigris; dorso postico et uropygio albis; caudâ nigrâ: rostro nigro: pedibus pallidè cruentatis.

Art. XXX.—*On some additions to the Collection of Birds in the Colonial Museum.* By Walter L. Buller, D.Sc., F.L.S., etc.

[*Read before the Wellington Philosophical Society, 10th February,* 1875.]

I have much pleasure in laying before the Society this evening several ornithological novelties lately added to the collection in the Colonial Museum, and kindly submitted to me by Dr. Hector for determination.

Numenius uropygialis, *Gould.*

The first specimen to be noticed is an example of the Australian Whimbrel, obtained a short time since by Mr. Liardet in the Wairau, and presented to the Museum by our Vice-President, W. T. L. Travers, Esq., F.L.S.

I have carefully compared the specimen with the descriptions of this and the allied species in Gould's Birds of Australia, and in Finsch and Hartlaub's Birds of Central Polynesia, and I feel no hesitation in assigning it to *Numenius uropygialis.* Gould states that this form is somewhat smaller than the European bird, *Numenius phæopus* (=*femoralis*, Peale); and the New Zealand example, as will be seen from the following comparative statement of measurements is even smaller than Gould's type. The colours and markings of the plumage, however, leave no doubt on my mind that it is the species described by Mr. Gould under the above name; and we may, I think, safely conclude that the example before us is an accidental straggler from Australia.

	Bill. In.	Wing. In.	Tail. In.	Tarsus. In.
N. uropygialis, according to Gould ...	3	9·5	3	2·25
New Zealand example	2·4	8·75	3·25	2·2

2. Numenius cyanopus, *Vieillot.*

In company with the bird noticed above, Mr. Liardet observed, and afterwards succeeded in shooting, a fine specimen of the Australian Curlew,

(*Numenius cyanopus*). I have not myself seen it, but Dr. Hector, through whose hands it passed, had no difficulty in determining the species by comparing it with Australian examples in the Colonial Museum.

3. HIMANTOPUS NOVÆ-ZEALANDIÆ, *Gould.*

Among the specimens on the table there is a remarkable albino variety of the Black Stilt, also obtained by Liardet in the Wairau, and purchased by Dr. Hector. The entire plumage is white, clouded with smoky grey on the crown and sides of the head, and on the upper surface of the body. There are a few straggling black feathers on the wings, back and rump, and the under surface of the quills is mottled with grey. The primaries and secondaries, it may be further mentioned, are much abraded or worn on both sides of the shaft.

4. ANAS SUPERCILIOSA, *Gmelin.*

The specimen exhibited, which was obtained in the Wairarapa Lake, appears to me to be merely an abnormal variety of the common Grey Duck. It is much larger than ordinary examples, and presents some peculiar markings in the plumage. There is a broad irregular patch of white on the lower part of the foreneck; the speculum on the wings is nearly obliterated, the secondaries being dull white on their outer webs, while their coverts have a broad terminal band of pale brown and white. The two outer primaries in one wing, and the second and third in the other, are entirely white. There are likewise some eccentric markings on the feathers of the crop and sides of the breast. These individual peculiarities may be due, as Dr. Hector has suggested, to hybridization—possibly the result of a cross with the domestic duck.

5. STERCORARIUS PARASITICUS, *Linn.*

The Colonial Museum has recently received a fresh specimen of Buffon's Skua, in immature plumage, but I have not yet been able to ascertain where it was killed. This is only the second recorded instance of the occurrence of this species in New Zealand. (See Birds of New Zealand, p. 268).

6. PHALACROCORAX BREVIROSTRIS, *Gould.*

The specimen now exhibited to the meeting would seem to favour the view held by some collectors that there is a small Black Shag in New Zealand distinct from *P. brevirostris*. The young of that species is known to be entirely black (see Birds of New Zealand, p. 330); but here we have an adult bird exhibiting a seasonal change of plumage from a rusty or brownish black to the glossy black, and without any indication of white on the throat or foreneck. For the present, however, we must treat it as a melanoid variety of the common species.

ART. XXXI.—*Preliminary Remarks on some New Zealand Birds.*

By OTTO FINSCH, Ph.D. of Bremen, Hon. Mem. N.Z.I., C.M.Z.S., Hon. Mem. Brit. Orn. Union, etc.

[*Read before the Otago Institute, 11th June,* 1874*.]

SINCE the publication of my Revision of the Birds of New Zealand (Journ. für Orn. 1872, pp. 81-112, 162-188, and 241-274) I have had the pleasure of again examining a good many New Zealand birds, having received a valuable collection from my excellent friend Dr. Haast, and many rare and important species through the kindness of Captain Hutton, Dr. Hector, Mr. Kirk, and Mr. Purdie. The New Zealand Institute forwarded to me, with incomparable liberality, a most valuable collection of rare types for comparison, which has been very useful to me in my researches on New Zealand ornithology, and it is with great pleasure that I pay my heartiest thanks to all my friends who have assisted me so effectually in my labours. I now beg leave to offer the results of my investigations, which, although short, contain useful notices on many New Zealand birds, and are an abstract of a more extensive paper that will shortly appear in the Journal für Ornithologie, under the title of Corrections and Additions to my Revision of the Birds of New Zealand.

This paper may be regarded as the forerunner of my Synopsis of the Birds of New Zealand, which I hope to be able to offer to my scientific friends in New Zealand in a short time. This little book, which will be printed in English, will contain descriptions and a brief history of all the native birds of New Zealand, which number at present about 156 species, a subject on which I have been working zealously and with great care for more than seven years.

No. 1,† p. 87. *Falco novæ-zealandiæ*, Gml.

The question whether there are two or one species of Falcon in New Zealand has not yet been settled satisfactorily. Dr. Buller, in accordance with Dr. Haast and Mr. Gurney (Ibis 1872, p. 332), expresses his belief that there are two—a larger and a smaller; but he does not give, even in his large work, sufficient characters to distinguish them. The valuable remarks by Captain Hutton (Ibis, 1873, p. 100), and Mr. Sharpe (*ib.*, p. 328), prove also that further researches are required to settle the question.

No. 2, p. 92. Instead of *Circus assimilis*, Jard., put *C. approximans*, Peale.

As it is impossible to make out the *C. assimilis* of Jardine and Selby without comparison with the type, and as it will most probably turn out to be the young of *C. jardinii*, as stated by Lord Walden (Trans. Z.S. VIII., 1872,

* Dated at Bremen 5th April, 1874.

† The numbers relate to my Revision der Vögel Neuseelands, as cited above.

p. 37), the name given by Peale, who undoubtedly described the New Zealand Harrier, must stand for our bird. I lately received, through the kindness of Dr. Haast, an old male, and I am convinced that the New Zealand bird corresponds altogether with those from Australia and the Fiji Islands.

No. 4, p. 95. *Sceloglaux albifacies*, Gray.

Having, through the kindness of Dr. Hector and Mr. Purdie examined two specimens of this rare Owl, I have no doubt of the validity of its generic position.

No. 5, p. 96. *Stringops habroptilus*, Gray.

Dr. Buller declares that *Str. greyi* is but an accidental variety of this bird, which may be right. But as the single specimen in the British Museum, which I examined carefully many years ago, exhibits striking peculiarities, I do not feel quite sure about it, and think it possible that *Str. greyi* may be some day rediscovered.

P. 98. After *Platycercus auriceps* must follow—

Platycercus alpinus, Buller, which is not the young of *Pl. auriceps*, as repeatedly maintained by me, but a good species. I received old and young specimens of both through Dr. Hector, which convinced me that I was wrong.

No. 12, p. 104. *Chrysococcyx lucidus*, Gml.

Chry. plagosus, Hutton, Ibis, 1872, p. 246.

Captain Hutton says that the Chatham Island Bronze Cuckoo is not the same as the New Zealand one, but is *Chr. plagosus* of Australia, in which opinion I do not agree, after having compared a specimen from the Chathams lent me by the N.Z. Institute. The under parts show a little broader gold green crossbands, and the second tail-feather instead of two well defined rusty bands has only indications of them, but there is no other difference, and I see no reason to separate the Chatham Island bird from the New Zealand *Chr. lucidus*.

P. 105. The Fam. *Upupidæ* must be omitted, as the genus *Heteralocha* is not a Upupine form at all, but belongs to the family *Glaucopidæ*.

No. 17, p. 107. *Anthornis melanocephala*, Gray.

I received specimens of this excellent species through the kindness of Dr. Hector.

P. 109. The Fam. *Certhiadæ* does not occur in New Zealand, as the genera *Acanthisitta* and *Xenicus* really belong to the Fam. *Troglodytinidæ*, being most nearly allied to *Tesia* and *Pnöepyga*.

No. 20, p. 109. *Acanthisitta chloris*, Sparrm.

Among a series of specimens forwarded to me by Dr. Haast I find two

which apparently belong to a second species, hitherto overlooked, which will turn out to be *Acanthisitta citrina*, Gml.

The colours are nearly the same as in the specimen described by me in the Jour. für Orn. 1870, p. 252, but the feathers on the whole of the upper parts are pale brownish, with narrow black lateral margins and the quills, legs, and hind toe are considerably longer, as will be seen by the following measurements, given in decimal parts of an inch :—

	Al.	Caud.	Rostr. a front.	Tars.	Dig. med.	Dig. post.
A. citrina ...	2·15	·87—·98	·43	·82	·55	·4
A. chloris (12 spec.)	1·67—1·8	·7 —·87	·35—·43	·66—·75	·4—·55	·27—·31

I recommend my ornithological friends in New Zealand to keep watch for this stouter form in order to ascertain if it is a true species.

No. 21, p. 109. *Xenicus longipes*, Gml.

The figure in the Voyage of the Erebus and Terror (t.3, f.1), copied from an original drawing of Forster, is totally incorrect and cannot be taken in comparison. I have, therefore, no doubt but that Dr. Buller is quite right in uniting *X. stokesii* with *longipes.*

No. 23, p. 109. *Xenicus gilviventris*, Pelz.

Through the kindness of Dr. Hector I received the type of *X. haasti*, Buller, which is undoubtedly synonymous with the above-named species.

No. 24, p. 110. Instead of *Orthonyx* write *Clitonyx ochrocephalus*, Gml.

On the systematical position of this bird see my extensive paper "Ueber die systematische Stellung der Neuseeländischen Gattungen *Clitonyx* Reichb. und *Phyllodytes*, Finsch"—(Jour. f. Orn. 1873, p. 393).

P. 110. Before No. 25 place Fam. *Paridæ*, and instead of *Orthonyx* write *Phyllodytes albicilla*, Less. ; Finsch, Jour. f. Orn. 1873, p. 398.

Having had the pleasure of becoming acquainted with this species through the kindness of Captain Hutton, I was at once convinced that it is by no means the northern representative of the foregoing species, as Dr. Buller says, but that they belong to totally different families.

No. 26, p. 110. *Certhiparus* must become *Phyllodytes novæ-zealandiæ*, Gml. ; Finsch, Jour. f. Orn. 1875, p. 397.

No. 27, p. 111. *Sphenœacus punctatus*, Quoy.

I have examined specimens from the Rakaia, received through the kind assistance of Dr. Haast.

No. 29, p. 112. *Sphenœacus rufescens*, Bull.

This is not the same as *Sph. fulvus*, Gray, as suggested by me, but is a very good species. I received specimens from the Chatham Islands through Dr. Hector.

No. 30, p. 112. *Myioscopus longipes*, Less.

A careful examination of the types brought home by the French expedition will be necessary to make out the true *Muscicapa longipes*, Lesson. *Turdus australis*, Sparrm. (= *T. albifrons* var. *b*, Gml.), will probably turn out to be the northern species, which I have not yet had the pleasure of examining.

No. 32, p. 161. *Gerygone flaviventris*, Gray.

My friend Dr. von Pelzeln, with his usual kindness, sent me the type of his *G. aucklandica* (Novara-Reise, 1865, p. 65) for comparison, and I have not the slightest doubt but that it is the young of *G. flaviventris*.

No. 33, p. 162. *Gerygone igata*, Quoy.

Dr. Buller had no right to expunge this species from the list of New Zealand Birds, as there is no reason to doubt the statement of the French travellers that they procured their type near Tasman Bay. Notwithstanding certain differences between *G. flaviventris* and the description and figure in the Voyage of the Astrolabe, I should not wonder if the true *igata* turned out to be that species, but this can only be settled by comparing the type.

No. 34, p. 162. *Gerygone albofrontata*, Gray.

Of this remarkable species I received a specimen for comparison by the kind assistance of Dr. Hector, from the Colonial Museum in Wellington.

Gerygone sylvestris, Potts, Trans. N. Z. Inst. V., p. 176.

This is certainly not identical with the foregoing species, as Dr. Buller expresses his belief, but seems to be a good species.

No. 37, p. 163. *Myiomoira macrocephala*, Gml.

Having again examined a large series of this species, amongst them typical specimens of *M. dieffenbachii*, Hutt., and one from the Chatham Islands, I feel quite sure that *dieffenbachii* cannot be separated specifically, as there exist all phases in the amount of bright orange on the breast. Captain Hutton is certainly wrong in referring the orange-breasted specimens to *M. dieffenbachii*, as these just form the true *macrocephala*. It does not occur in the North Island as I wrongly noticed.

No. 38, p. 164. *Myiomoira toitoi*, Less.

This North Island species I got for examination through the Colonial Museum at Wellington.

Myiomoira traversi, Hutt.

This is an excellent species, forwarded to me through the kindness of Dr. Hector, but not congeneric with *Myiomoira* (*Miro*) *longipes* as Dr. Buller thinks.

No. 39, p. 164. *Rhipidura flabellifera*, Gml.

Dr. Hector kindly lent me a specimen from the Chatham Islands which agrees very well with those from New Zealand.

No. 39, p. 164. *Rhipidura fuliginosa*, Gml.

Through Dr. Haast and Dr. Hector I got a good many specimens of this species, and among them some with white feathers above and below the eye; so there can be no doubt that the *Rh. melanura* is this species.

No. 273, p. 165. *Colluricincla concinna*, Hutt.
Graucalus melanops, Hutt., Ibis 1872, p. 201.
Graucalus concinnus, Hutt., Trans. V., p. 226.

is *Graucalus parvirostris*, Gould, as I can state positively, after having examined one of the typical specimens shot near Invercargill, forwarded to me through the kindness of Dr. Hector. The characters pointed out by Captain Hutton as being of specific value are only signs of a younger age, and may be observed also in other species of the genus. The few specimens observed in New Zealand are no doubt accidental stragglers from Tasmania.

P. 166. In place of Fam. *Corvidæ* put "Fam. *Ptilorhynchinæ*, Sundev.," in which both species of the genus *Keropia* must be placed.

P. 167, before No. 45, put "Fam. *Glaucopidæ—Callæadinæ* Sundev., Méth. Nat. Av., 1872, p. 40," embracing the genera *Glaucopis*, *Heteralocha*, and *Creadio*. The characters of this family have been pointed out very exactly by Prof. Sundevall (l.c.).

P. 167. Sub-fam. *Sturninæ* must be expunged, as *Creadio* is not a Starling at all.

No. 48, p. 167. *Creadio carunculatus*, Gml.

Latham and Quoy (Voy. l'Astr., t.12) were acquainted with the young bird (*Cr. cinereus*, Buller).

No. 47, p. 167. *Aplonis zealandicus*, Quoy.

The French naturalist collected the singular bird described under the name of *Lamprotornis zealandicus* (Voy. l'Astr., t.9, f.1) near Tasman Bay, and nobody has any right to expunge it from the avifauna of New Zealand, although it has not been rediscovered since.

No. 51, p. 168. *Charadrius fulvus*, Gml.

The only specimen said to have been obtained in New Zealand, and which existed in any New Zealand Museum, I got for comparison from the Auckland Museum through the kindness of Mr. Kirk.

No. 24, p. 169. *Thinornis novæ-zealandiæ*, Gml.

I had the pleasure of receiving a specimen from the Chatham Islands through Dr. Hector, and consider *Thinornis* to be a valid genus. As we learn from Dr. Buller, *Th. rossii*, Gray, is certainly the young of this species.

No. 62, p. 172, *Ardea sacra*, Gml.

The fact that no white specimen of this species has yet been observed in

New Zealand, where it is generally rare, does not at all prove that the white bird must be a different species as Dr. Buller maintains. I have had ample opportunity of observing that in *A. sacra* the white variety is accidental as in the African *A. gularis*, Bosc., or in the American *A. cærulea*, L., for dark and white ones breed together (*vide* Finsch, Jour. f. Orn. 1870, p. 136).

No. 66, p. 173. Instead of *Limosa uropygialis*, Gould, Gray's name of *novæ-zealandiæ* must stand in accordance with the rule of priority. *L. baueri*, Naum., used by Dr. Buller, is only a manuscript name without description, and has no claims to stand.

Himantopus spicatus, Potts, Trans. V., p. 198.

Although I have not seen the type, I consider this new species based upon a single specimen to be nothing else than *H. novæ-zealandiæ* in changed plumage.

No. 70, p. 174. *Tringa canutus*, L.

A New Zealand specimen kindly sent me by Dr. Hector agrees very well with European ones, and does not belong to *Crassirostris* as suggested by me (Trans. V., p. 209).

No. 71, p. 174. *Gallinago aucklandica*, Gray.

I have examined a pair from the Chatham Islands forwarded by Dr. Hector. Dr. Buller declares his *G. pusilla* to be the same.

No. 73, p. 174. *Ocydromus troglodytes*, Gml.

To this species belongs *O. australis*, Buller, Hist. Birds N. Z., p. 170, (*e fig. opt.*)

Ocydromus hectori, Hutton, Jour. für. Orn. 1873, p. 329.

This I consider to be a good species after having compared a typical specimen kindly lent me through the Colonial Museum at Wellington.

No. 74, p. 178. *Ocydromus australis*, Sparrm.; Hutt., Jour. f. Orn., 1873, p. 399; Finsch, *ib.*, p. 402.

This is *O. earli*, Buller, Hist. B. N. Z., p. 165 (*e fig. opt.*)

No. 75, p. 179. *Ocydromus earli* (? Gray): Hutt., Jour. für Orn. 1873, p. 401; Finsch, *ib.*, p. 404.

Dr. Buller, in his great work, unfortunately does not mention the typical specimen of *O. earli*, Gray, and not having compared it myself, I am unable to make out whether the true *earli* is indeed the bright cinnamon-red bird as Captain Hutton and I believe, or whether it is the same as *O. australis* figured under the name of *earli* by Dr. Buller.

No. 76, p. 180. *Ocydromus fuscus*, Du Bus.

I did not compare the type of Du Bus, as Dr. Buller seems to think, but only the figure, which in many respects differs from the description.

Ocydromus finschi, Hutt.; Jour. f. Orn. 1873, p. 400.

After having examined one of the type specimens kindly sent me by Dr. Hector I take it, at present, for a good species, but I have some suspicions that it will finally turn out to be a variety of the foregoing. At least we still require more material to become fully acquainted with the members of this genus.

No. 77, p. 181. ***Rallus pectoralis***, Less.

The endeavour of Mr. Potts to protect his *R. pictus* as a good species (Trans. V., p. 199, pl. XVIII.) is without effect, and even the slight difference in the shape of the bill is not sufficient to convince me of the value of the species. On the variability of this species compare Finsch, Ornith. Centr. Polyn., p. 161; *id.* P.Z.S. 1871, p. 25; *id. ib.* 1872, p. 107; *id.* Jour. f. Orn. 1870, p. 136.

Rallus modestus, Hutt., Ibis 1872, p. 247.

As the type of this species was caught in the act of protecting its young, I cannot agree with Dr. Buller in considering with certainty *R. modestus* as the young of *R. dieffenbachii*.

No. 80, p. 182. *Ortygometra fluminea*, Gould, must be expunged from the list of New Zealand birds.

No. 88, p. 187. ***Rhynchaspis variegata***, Gould.

is synonymous with *rhyncotis*, Lath. An old male received through Dr. Haast agrees in every respect with Australian specimens in the Bremen Museum.

No. 95, p. 241. ***Lestris catarractes***, Ill.

Dr. Buller enumerates the Southern Skua under the name of *antarcticus*, Less., but unfortunately does not point out the specific characters.

No. 96, p. 241. ***Lestris longicaudus***, Briss.

L. parasitica, Hutt., et Bull., B.N.Z., p. 268.

Mr. Saunders believes the New Zealand specimen to belong to a new species, but I have no doubt that it is only a young specimen of the above species.

No. 99, p. 248. ***Larus pomare***, Bruch.

Through the kindness of Dr. Haast I received the type of *L. bulleri*, Potts, from the Canterbury Museum for comparison, and can state positively that it is a young bird of *pomare*. Dr. Buller declares *L. bulleri* (= *melanorhynchus*) to be different from *pomare*, after having seen the type in the museum at Mayence; but his comparison must have been very hasty, as I can state positively that *L. pomare*, Bruch (adult), is the true *melanorhynchus* of Buller = *bulleri*, Potts), whereas *L. pomare*, Bruch (young), belongs to

L. novæ-hollandiæ, as minutely explained by me (Jour. f. Orn. 1872, pp. 241-253) after having had the types of Bruch kindly lent me and studied most carefully.

No. 104, p. 254. *Hydrochelidon leucoptera*, Temm.

The single specimen shot in New Zealand was sent to me for comparison through the kindness of Dr. Hector. It certainly belongs to this species, and not to *H. hybrida* as suggested by me (Trans. V., p. 210.)

No. 105, p. 254. *Gygis alba*, Sp.

is not satisfactorily known as visiting New Zealand, and must be challenged.

No. 112, p. 255. *Procellaria parkinsoni*, Gray.

This excellent species, apparently peculiar to New Zealand, I had the pleasure to see amongst the birds kindly lent me by the N. Z. Institute. The interesting notes by Captain Hutton on the breeding of this species* on the Little Barrier are not quoted in Buller's work.

No. 113, p. 255. *Procellaria gouldi*, Hutton.

I got the type specimen from the Auckland Museum for comparison, and am quite sure as to its specific distinctness.

No. 115, p. 255. *Procellaria incerta*, Schl.

said to come from New Zealand, according to a label in the Leyden Museum, must be omitted from our list.

No. 117, p. 255. *Procellaria mollis*, Gould.

Dr. Buller does not allow this species a place among New Zealand birds, but as the Novara Expedition collected specimens in lat. 35° S., long. 175° 5′ E., there can be no doubt in respect to its proper place among the avifauna of New Zealand.

No. 123, p. 256. *Puffinus gavius*, Forst.

Although Forster's description does not exactly agree I am convinced with Captain Hutton that his name must stand for this species. *P. gavius*, of which I received a specimen through the kindness of Dr. Hector, is an excellent species, most akin to our *P. anglorum*, and has nothing to do with *P. opisthomelas*, Coues, and *P. dichrons*, H. and Finsch (*vide* P. Z. S., 1872, p. 108.) To the latter Polynesian species belongs *Pr. gavia* var. *ex.* Ins. Oriadea, Forst., and *P. tenebrosus*, Natt. (Pelz., Ibis 1873, p. 47), as I can state after having examined the type specimen kindly lent me through the kindness of Dr. von Pelzeln.

No. 124, p. 256. *Puffinus tristis*, Forst.,
must become *griseus*, Gml. (*ex* Grey Petrel, Lath., III., p. 399).

* Trans. N. Z. Inst. III., p. 111.

P. major, Gray, Voy. Ereb. and Terr., p. 17.
P. fuliginosus, Homb. (*nec* Strick).
P. amaurosoma, Coues.

Of this fine species I got a specimen from the Chatham Islands from Dr. Hector for comparison.

P. 256. After No. 124 add *Puffinus tenuirostris*, Temm.
Proc. æquinoctialis, Pall. (*nec* L).
Proc. atlantica, Bull., N. Z. Exhibition, p. 256.
Puff. brevicaudus, *id.*, Hist. B. N. Z., p. 315.

I received a specimen on loan from the Colonial Museum at Wellington' obtained in Cook Strait, which agrees exactly with the plate in Fauna Japonica (p. 131, t. 86). *Pr. brevicaudus*, Brandt, is a manuscript name only, and has no value.

P. 256, after No. 125 add *Halodroma berardi*, Quoy.

Brought from the Chatham Islands by Mr. H. Travers. (Hutt., Ibis 1872, p. 248.)

No. 126, p. 256. *Prion vittatus*, Gml.

To this most broad-billed species, of which I got specimens from the Chatham Islands through Dr. Hector, belongs *Prion australis*, Potts, Ibis 1873, p. 85.

No. 127, p. 256. *Prion banksii*, Smith.
Prion vittatus, Hutt., Cat. B. N. Z., 48.

No. 128, p. 257. *Prion turtur*, Sol.
Pr. banksii, Hutt., Cat. p. 48.
Pr. ariel, *id.*, p. 80.

I received a pair of this species from the Chatham Islands through the kindness of Dr. Hector, and having examined other specimens, I have no doubt that *Pr. ariel*, Gould, cannot be separated.

No. 130, p. 257. *Thalassidroma fregata*, L. (*nec* Forst.)
Th. marina, Hutt., Ibis 1872, p. 249.

Chatham Island specimens were kindly forwarded to me by Dr. Hector.

No. 131, p. 257. *Thalassidroma melanogastra*, Gould.

I received on loan from the Auckland Museum, through the kindness of Mr. Kirk, a specimen of this bird from New Zealand.

No. 132, p. 257. *Thalassidroma nereis*, Gould.

The single specimen procured at the Chathams by Mr. H. Travers I had the pleasure of examining, it having been kindly lent me from the Colonial Museum by Dr. Hector.

No. 133, p. 257. *Dysporus serrator*, Banks.

Hutton's valuable notes on this species, observed by him on the Great Barrier Island, are not mentioned in Dr. Buller's work.

No. 134, p. 257. *Graculus carbo*, L.

Dr. Buller feels sure that *Gr. carboides*, from New Zealand and Australia, is specifically different, but unfortunately does not mention the distinguishing characters.

P. 258, after No. 134, add *Graculus carunculatus*, Gml.

This species has been doubted by me as regards its occurrence in New Zealand, but having examined a specimen from the Chatham Islands, forwarded by Dr. Hector, I have no longer any doubt about it. *Gr. carunculatus* may be easily distinguished from *Gr. cirrhatus*, Gml., from Magellan Straits, in having the sides of the head and neck dark, and by having a feathered stripe along the naked gular and chin regions, which parts are totally naked in *cirrhatus*.

No. 136, p. 258. *Graculus (?) sulcirostris*, Brandt.

Although omitted in Dr. Buller's work, there can be no doubt that Mr. Peale collected a shag in the Bay of Islands, which, like *Gr. chalconotus*, Gray, has not yet been observed since. This species, *Gr. purpuragula*, Peale, seems to be very near if not identical with *Gr. stictocephalus*, Bp. = *sulcirostris*, Br.

No. 138, p. 259, add—

Graculus featherstoni, Buller. Ibis 1873, p. 90.
Graculus, nov. sp., Finsch, Jour. f. Orn. 1872, p. 274 (July).
Gr. africanus, Hutt. (*nec* Gml.), Ibis 1872, p. 249 (July).

An excellent and most beautiful species, of which I received a specimen through the kindness of Dr. Hector.

No. 139, p. 259. *Graculus brevirostris*, Gould.

A fledgling, received from Dr. Haast, is of a black colour throughout. I still doubt whether the true *Gr. melanoleucus*, Vieill. (Bull., Hist. B. N. Z., p. 333), will occur in New Zealand if really different from *brevirostris*.

Tachypetes minor (Gml.) must be included in the avifauna of New Zealand. (Bull., Hist. B. N. Z., p. 342.)

No. 141, p. 260. *Podiceps cristatus*, L.

I received the type of *P. hectori*, Buller, from the Wellington Museum, and wonder how Dr. Buller could venture to distinguish his species "by the total absence of white on the shoulders and quills," as the white on these parts is developed exactly as in our European *cristatus*.*

* See explanation in Buller's Notes on the Ornithology of New Zealand, Trans. N. Z. I., Vol. II., p. 388.—ED.

No. 143, p. 261. *Eudyptes pachyrhynchus*, Gray.

I doubt very much whether Dr. Buller is right in uniting this species with *Eu. chrysocomus*, Forst., and *nigrivestis*, Gould.

No. 144, p. 262. *Eudyptes chrysolophus*, Brandt. is still doubtful as a New Zealand species, being only included by me on the authority of a label in the Leyden Museum.

No. 145, p. 262. *Eudyptes antipodes*, Hombr.

A specimen captured on the shores of New Zealand was sent me for comparison through the kindness of Dr. Hector.

No. 146, p. 262. *Eudyptula minor*, Gml.

Having examined more specimens, I am unable to distinguish *Eu. undina* as a good species. The blue hue of the upper part varies considerably in its intensity, as also does the stoutness of the bill. A specimen from the Chathams, lent me by the Colonial Museum, has a stouter and heavier bill, and shows the under parts strongly tinted with grey, but this hue disappeared after having the specimen carefully washed, and I see no reason to distinguish it as a variety.

Eudyptula albosignata, Finsch, nov. sp., P. Z. S. 1874.

Through my friend Dr. Haast I received two specimens of an *Eudyptula*, named *minor*, from Akaroa Heads, which I cannot unite with *Eu. minor*, and must separate specifically for the present.

Char.—Size and general colours as in *minor*, but the upper tail-coverts with a patch of white, and the flippers underneath wholly white; very conspicuously bordered along the anterior and posterior edges with white, leaving only a narrow blackish middle band along the upper surface of the flippers.

No. 147, p. 263. *Apteryx australis*, Shaw.

I repeat that I cannot consider *A. mantelli* to be more than a local variety of this species, and beg to refer to the minute comparison given by me (*l.c.* p. 265).

No. 149, p. 271. *Apteryx haasti*, Potts.

With extraordinary pleasure I received one of the type specimens of this species through the excellent liberality of Dr. Haast for comparison, and have no doubt as to its specific distinctness. With respect to colouration, *A. haasti* almost entirely agrees with *A. oweni*, and is by no means darker, as Dr. Buller says, except the feathers on the hind neck and nape, which are a little darker, and without pale cross lines. But it may easily be distinguished by its large size, which agrees with that of *A. australis*.

Apteryx mollis and *A. fusca*, Potts (Trans. N.Z. Inst., V., p. 196), are very doubtful species, and require further verification.

ART. XXXII.—*On the Occurrence of* Lamna cornubica, *Porbeagle Shark, Flem., the Mako of the Maoris, in New Zealand.*

By JULIUS HAAST, Ph.D., F.R.S., Director of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 2nd April,* 1874.]

THE Canterbury Museum received a few days ago from Mr. W. H. Webb, of Laverick's Bay, Banks Peninsula, the skin of a shark, which upon examination proved to belong to *Lamna cornubica*, the Porbeagle shark of older English authors, and which, according to Dr. Günther (Catalogue of Fishes, British Museum, Vol. VIII., page 390), has hitherto been observed only in the northern hemisphere, as the specimens alluded to in that standard work were obtained in the Atlantic, the Mediterranean, and Japan.

Captain Hutton in his Catalogue of New Zealand Fishes, page 77, refers the teeth of the Mako of the Maoris, and which are worn by the latter as ear-ornaments, to *Lamna glauca*. If the specimens examined by him belong really to that or the nearly allied species *L. spallanzanii*, they ought to be without basal cusps, whilst the specimen under consideration, and now the property of the Canterbury Museum, has the basal cusps well developed. From this fact alone it appears that the latter cannot belong to *Lamna glauca*, but must represent some other species, either of cosmopolitan habits or confined to the southern hemisphere, as for example, the *Notidanus indicus* of the southern seas which represents the *Notidanus griseus* of the northern hemisphere.

Two Maori carvers from Poverty Bay, Northern Island, at present occupied at the museum, pronounced the skin to belong to a young Mako and informed me that this fish when in an adult state was about 12 feet long, and that the teeth in old and young had always the small basal cusps on each side of the lanceolate tooth; consequently, if the teeth examined by Captain Hutton are without basal cusps, there must be several species of *Lamna* inhabiting the coast of New Zealand.

The animal to which the skin belonged was 4 feet 10 inches long; head, back, sides and fins are of a slaty colour; chin, belly and posterior side of the fins near the root dirty white; teeth lanceolate, long, with sharp lateral edges, with a small basal cusp on each side, three rows in each jaw and parallel with each other.

In the lower jaw the first outer row contains three on each side, whilst the second and third rows consist of thirteen each.

In the upper jaw there are three teeth on each side of the outer row and thirteen teeth in the middle and inner rows respectively; of these the third tooth on each side and in each row is remarkably small.

In other respects, as to form of head, position of mouth, gills and fins, our specimen accords perfectly well with the specific characters of *Lamna cornubica* as given by Dr. Günther, and I have therefore assigned the remains in question to this species, although that eminent ichthyologist observes that in young specimens the basal cusps are absent.

Postcript. 2nd November, 1874.—Since this paper was written the Canterbury Museum has received the remains of another specimen referable to the same species, which was obtained in Lyttelton Harbour; it was 7 feet 6 inches long. In its dental arrangement, although the teeth are somewhat larger, it accords entirely with the former example.

Art. XXXIII.—*On the Occurrence of* Leptocephalus longirostris, *Kaup, on the Coast of New Zealand.*

By Julius Haast, Ph.D., F.R.S., Director of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 15th September,* 1874.]

As far as I am aware no specimen of the *Leptocephalidæ*, Bonaparte, a curious family of anguilliform fishes, called glass-eels by the sailors, and distinguished by a low form of organisation, has yet been noticed as having been obtained on the coasts of New Zealand.

These curious small fishes, which are more or less transparent, sometimes as thin as paper, possess only a cartilaginous vertebral column, and seem to be inhabitants of the high seas only.

A specimen presented by Mr. John Grigg, of Long Beach station, to the Canterbury Museum, which was picked up on the Ninety-mile beach during the strong north-east storm towards the latter part of the month of August, proved on examination to agree with *Leptocephalus longirostris*, of Kaup, which was first obtained at Messina, in the Mediterranean. The following specific characteristics are given by Dr. Günther in the Catalogue of Fishes in the British Museum, Vol. VIII., p. 141:—Body much compressed, elevated and short, the upper and lower profiles abruptly rising behind the head; head low, rather long; eye of moderate size; tongue not free in front; jaws toothed; muscular striæ vertical.

In the Catalogue of Apodal Fish, by the late Professor J. Kaup, the species in question is figured on Plate XVIII., Nos. 14 and 14*a*.

Total length of our specimen, 8·25 inches; greatest depth, ·85 inch; length of head, ·27 inch.

The remarkably transparent head—well preserved in our specimen, and very small when compared to the length and height of the body—gains, however, prominence by the large silvery eye, by which that transparency becomes still more conspicuous.

ART. XXXIV.—*Notes on New Zealand Ichthyology.* By JAMES HECTOR, M.D., F.R.S., Director of the Geological Survey of New Zealand.

Plates X. and XI.

[*Read before the Wellington Philosophical Society, 25th July,* 1874, *and* 10*th Feb.*, 1875.]

LIST OF FISHES CAUGHT ON THE WEST COAST OF OTAGO, JANUARY–FEBRUARY, 1874.

	Preservation, Cuttle Cove.	Chalky, South Port.	Dusky, Pickersgill.
Oligorus gigas	...	...	*
Scorpis hectori	...	...	*
Chilodactylus macropterus ...	*	*	*
Latris hecateia	*	*	*
Mendosoma lineata	...	...	*
Latris ciliaris	*	*	*
Sebastes percoides	*	..	...
Scorpæna cruenta	*	*	*
Trachurus trachurus	...	...	*
Percis colias	*	*	*
Notothenia coriiceps (?) ...	...	...	*
Trypterygium varium ...	*	...	...
Labrichthys fucicola	*	*	*
" bothryocosmus ...	*	...	...
" psittacula ...	*	*	*
Odax vittatus	*	*	*
Coridodax pullus	*	*	*
Haplodactylus meandratus ...	...	...	*
Lotella bacchus	...	*	...
Pseudorhombus scaphus ...	*	...	...
Monacanthus convexirostris ...	...	*	*
Acanthias vulgaris	...	*	*
Mustelus antarcticus	...	*	*
Galeus canis	*	...	*
Bdellostoma cirrhatum ...	...	*	...

During the past year I have enjoyed several favourable opportunities of obtaining a further acquaintance with the fishes on the coasts of the colony, and particularly during a cruise in January last in his Excellency Sir James Fergusson's yacht Blanche round the south-west coast of Otago, in the course of which the trammel-net was frequently used in Preservation Inlet, Chalky Inlet, and Dusky Bay. Continuous observations of the temperature of the sea were also made, and it was found that at that season the surface of the sea on the East Coast and in Foveaux Strait averaged 56·5°, but on rounding the West Cape and in the Sounds the temperature of the surface water is 61°. From a few observations made with the Miller-Casella

thermometer it was found that at from 17 to 25 fathoms depth on the West Coast, where the high surface temperature prevailed, the sea had the same temperature as the surface water on the East Coast. This appears to indicate that the warm Australian current is spread over the surface of this part of the ocean in a very thin stratum.

The above is a list of the fishes caught in the Sounds I have referred to. Frequently as many as 70 to 80 fish, of from 2 to 15 pounds weight, were obtained at a single haul of the net after it had been set for only an hour, the most abundant being the pakirikiri or rock cod (*Percis colias*), the tarakihi (*Chilodactylus macropterus*), and the wrasse (*Labrichthys fucicola*).

1* PLECTROPOMA HUNTII. sp. nov.

Pl. X.

B. 6; D. 10–20; P. 15; V. 1–5; A. 2–1–8; L.L. 50; L.T. 8 | 20.

Length equal to three times the height, head two and a half times in length; snout produced, lower jaw longest; base of spinous dorsal slightly exceeds that of the soft in length; upper jaw free, nostrils close to the orbits, anterior pair tubular.

Dorsal fin commences at one-third the total length, and over the posterior angle of the operculum; fourth spine longest, being twice the height of the first and last; soft dorsal of equal height; base of dorsal scaly, a scaly lobe extending to half the height of each spine in front.

Cleft of mouth oblique, equal to the height of longest dorsal spine, and twice the diameter of the eye, which is twice the interorbital width; upper maxillary broad and thin behind; teeth in villiform bands in both jaws, with six strong canines, two above and two below in the front, and one on each side in the lower jaw.

Præoperculum simple, ascending limb with minute denticulations, horizontal limb with two flat spines directed forwards; opercle with a superior notch, and a blunt membranous angle, with three flat sharp spines on the surface, the two lower being more distinct than the upper.

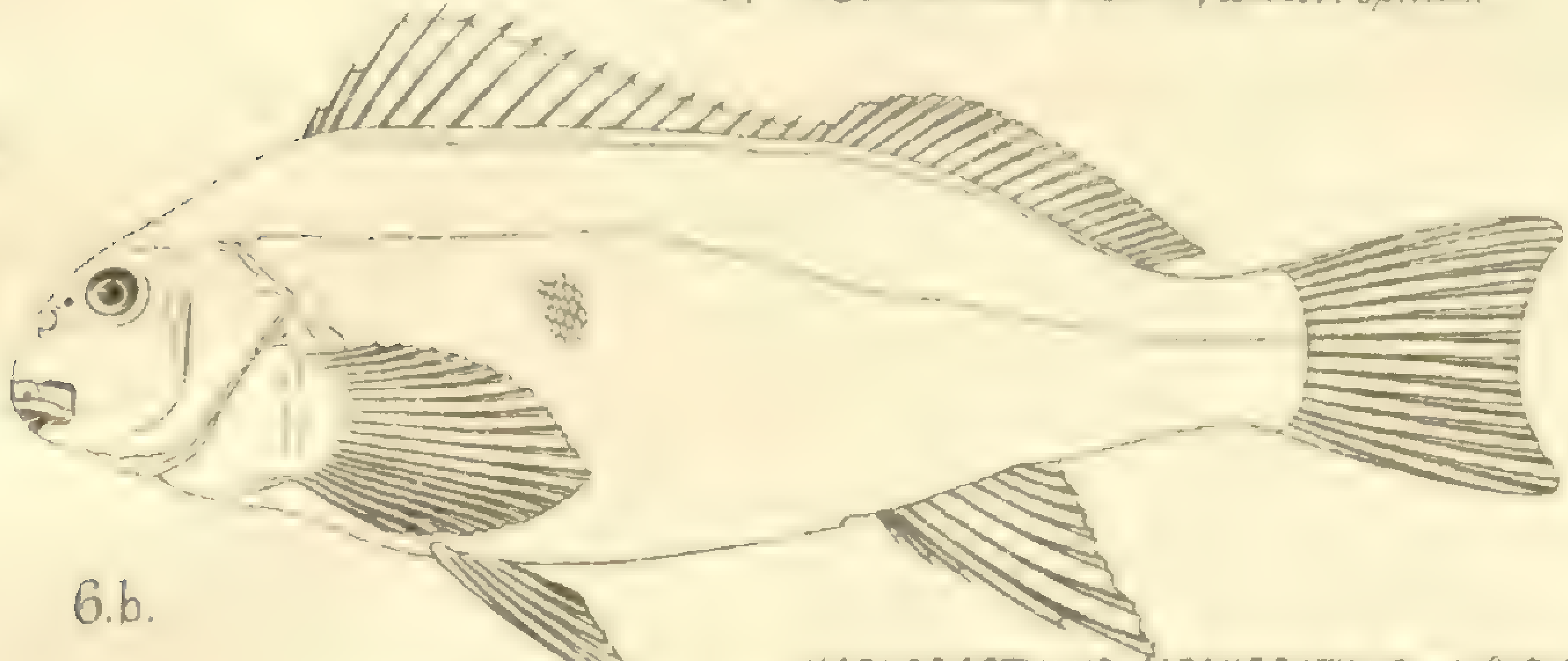
Pectoral rounded, with the middle ray slightly produced, extends to the commencement of the anal; ventrals shorter than the pectorals, and inserted slightly in advance of them; base of anal half the length of the soft dorsal; second spine thick and longer than the first ray, which is simple, being a slender spine adherent to the soft rays; fourth soft ray is the longest. Caudal equal in length to the ventral and rounded at the angles.

Scales moderate size, ctenoid. Lateral line curved.

Colour, red beneath, sides and back yellow, with dark patches of brown

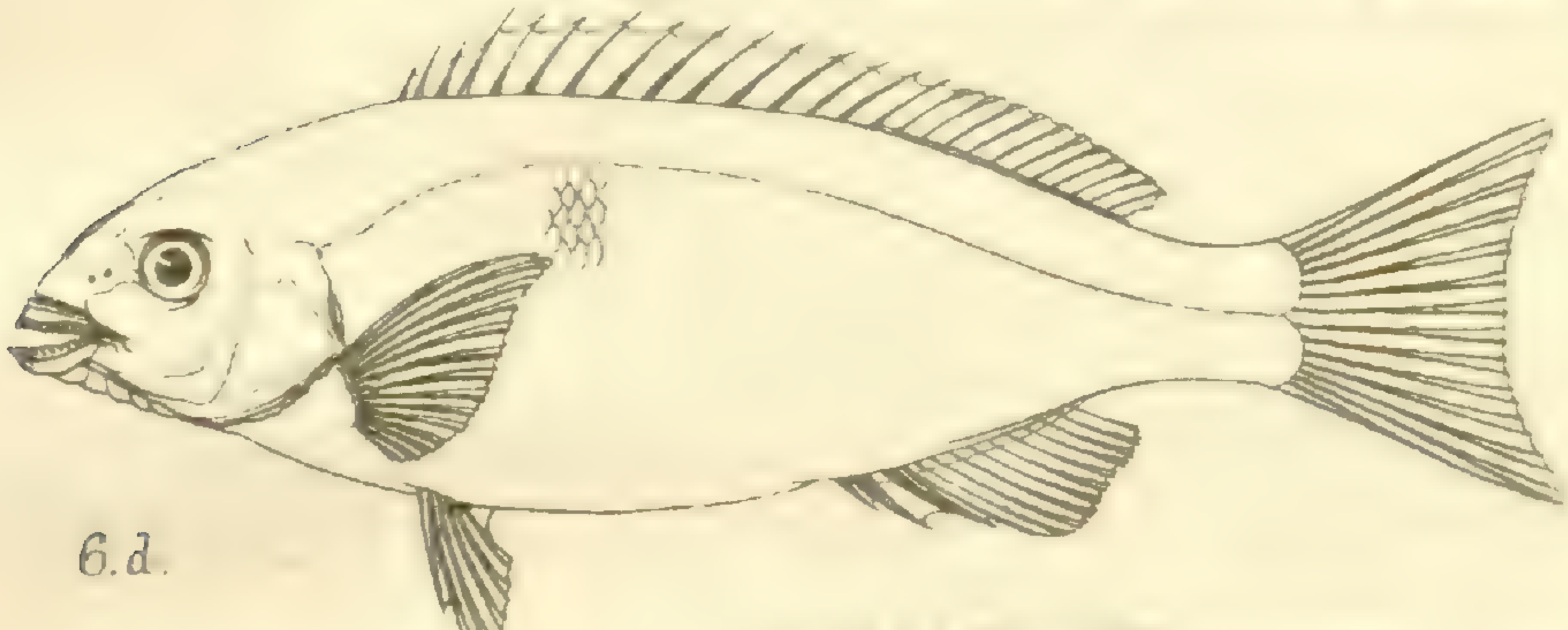
1.*

PLECTROPOMA HUNTII, Hector. sp. nov.



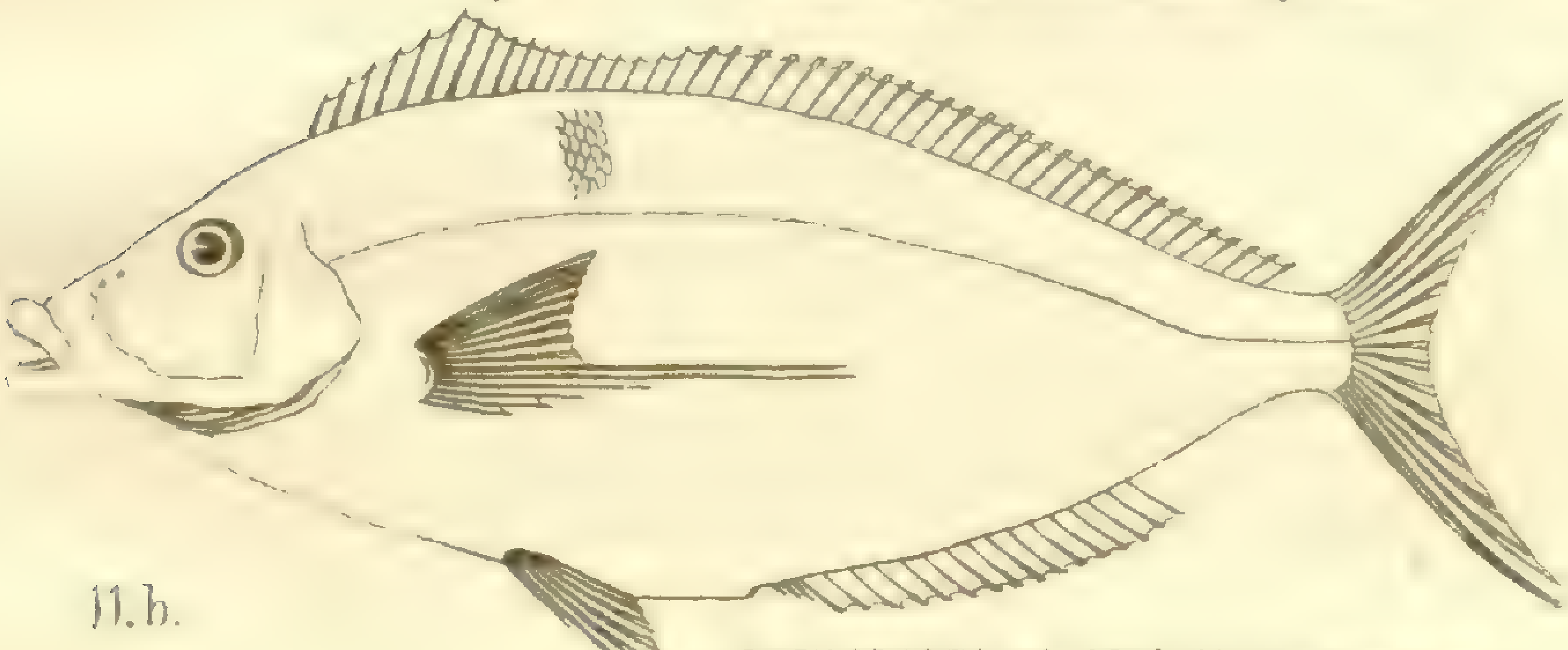
6.b.

HAPLODACTYLUS MEANDRATUS banks & Sol.



6.d.

GIRELLA PERCOIDES, Hector, sp. nov.



11.b.

CHEILODACTYLUS DOUGLASII, Hector, sp. nov.

15.a.

SCORPÆNA BARATHRI, Hector, sp. nov.

J.B. del. et lith.

about the head, and several broad vertical bands of brown. A black spot on the snout.

Chatham Islands. Presented by F. Hunt, Esq.

This fish approaches *P. annulatus*, Günth. (I., 158), the habitat of which is unknown, but has one less branchiostegal, a more elongated form, spinous and soft dorsals of equal length, different number of fin rays, and greater development of second anal fin. In some of these respects it resembles *P. dentix*, Rich. (Voy. Ereb. and Terr., p. 117), which is from King George's Sound.

4a. SCORPIS FAIRCHILDI. sp. nov.

Native name—Mata.

S. hectori, Hutton, Trans. N. Z. I., V., p. 259, pl. vii.

Captain Hutton's description of the fish from the Bay of Plenty is very different from that of his original type from the West Coast Sounds, and a comparison of the specimens and further observation of the habits and appearance of the West Coast fish have convinced me that they are distinct species, and that the general outline of *S. hectori* is correctly given in pl. I., fig. 4, Cat. Fish. N. Z., while the figure quoted above is an equally correct representation of the second species, which I propose to name after Captain Fairchild, of the colonial gunboat Luna, who presented the specimen to the Colonial Museum.

In *S. hectori* the profile of the head descends abruptly, and the body is short, the height being contained only twice in the length; the pectoral fin is the same length as the head, and has the middle rays the longest. In many hundred specimens I have observed the round black spot on the side is always present. It is a beautiful fish when seen in the deep transparent water of the Sounds swimming about among the rocks in large shoals like gold-fish.

In *S. fairchildi* the shape of the body is fusiform and elongate, the height being only one third of the length; the abdominal cavity is one third of the length; the peritoneum having a nacreous lustre; œsophagus lined with brush-like tufts; stomach tubular, with a contracted pyloric branch reflexed at an acute angle; walls fleshy and rugose; seven pyloric appendages; liver small; intestines membranous, with many convolutions, being eleven times the length of the cavity. Generative organs (male) equal to stomach in length; air bladder large.

6b. HAPLODACTYLUS MEANDRATUS. Banks and Sol.

Pl. X.

Native name—Kehei.

Aplodactylus meandratus, Rich., Zool. Trans. III., 83.

P. $\frac{8}{6}$–$\frac{7}{7}$; D. 16·1/20; V. 1–5; A. II. 1/7; L.L. 176; L.T. 60.

Length equal to four and one third that of head, and to three times the height; body nearly round, thick in front; snout truncate, tumid, interorbital

space convex; gape straight, almost inferior, its length being less than the interorbital distance; mouth has tumid reflexible lips; both jaws armed with several closely set rows of small tricuspid lancet teeth; patch of setaceous teeth on palate and on pharynx; tongue very short, smooth; four nostrils, anterior pair with tubular processes; præoperculum entire; operculum with a shallow notch; no pores about the head.

Both dorsals are set on a fleshy base; the two first spines of the dorsal are short, being less than the diameter of the eye; fifth spine is longest, and two and a half times in the height; fifth ray of soft dorsal the longest, and equal to spinous; length of soft dorsal is nine thirteenths of an inch.

Anal with fourth ray longest, the base being short by one third of first dorsal, with one spinous and one simple ray; caudal straight, the rays being equal to half the base of first dorsal; pectoral with six or seven simple and partly free rays, the middle ray being the longest; ventral with one thick simple ray and five divided rays, the third being the longest.

Scales small, oblong, cycloid.

Colour uniform, but darker above and about the head; rich olive-brown in vermiform marblings on a yellowish-grey ground, resembling a laminarian sea-weed encrusted with *Flustra* and *Spirorbis.*

Stomach elongated cylindrical, with thick rugose walls, and half the length of the abdominal cavity; liver forms a collar-shaped mass round the superior end; three short pyloric cæca; intestine membranous, and five times the length of the abdominal cavity; urinary organ very large, exceeding the liver in bulk; stomach and intestines full of corallines and sea-weed.

Largest specimen—total length, 22 inches.

The foregoing description is from several specimens caught in a trammel net by His Excellency the Right Hon. Sir James Fergusson, Bart.; Pickersgill Harbour, Dusky Bay, 3rd February, 1874.

This species resembles the fish described by Dr. Haast as *H. donaldii* (Trans. N. Z. I., V., p. 272); but there is no doubt that it is the same fish that was got by Captain Cook's expedition, figured by Banks and Solander and described by Sir John Richardson, as I have found it on all parts of the coast, and specially abounding round the headlands from the Kidnappers to East Cape where Captain Cook's specimen was obtained. It is caught in large numbers by the natives in the deep runlets excavated by the sea in the chalk marl strata which form the coast line, and for this purpose they use a peculiar net called the koko. This is a large scoop made with a bag-net suspended between two poles. With the rising tide this net is placed so as to block up one of the narrow runlets, and the fish are chased into the net from their hiding places among the kelp. Its flesh is coarse, with a rank flavour.

6c. HAPLODACTYLUS FERGUSSONI. sp. nov.

Native name—Hiwihiwi.

P. 6/8; D. 13/18; A. 3/6; V. 1/5; L.L. 60; L.T. 25.

Head three and a half times in the length and equal to the height; snout produced, profile concave, eyes prominent, their diameter being equal to half the gape; cheeks scaly; mouth deeply cleft, with thick lips; upper jaw formed by intermaxillaries; teeth minute, trenchant, lance-shaped, with single points in several rows on both jaws and a patch on the vomer; scales oblong, large, equal to half the orbit, cycloid, with six rays on attached margin.

Colour, grey-brown spotted with blue, white beneath.

Takes the hook, and is occasionally caught along with tarakihi. Stomach contained limpets and other shell-fish. Kawakawa Bay, East Cape, March, 1874.

Total length, 11 inches.

The six lower pectoral rays being simple, place this sparoid fish in the genus *Haplodactylus*, forming thus an exception to the other species of the genus, which are all vegetable feeders. The Maoris prize the hiwihiwi highly as food, considering it hardly inferior to the maomao (*Ditrema violacea*). I have dedicated this species to His Excellency Sir James Fergusson, to whom the Museum is indebted for many valuable specimens of the marine fauna of the New Zealand coasts.

6d. GIRELLA PERCOIDES. sp. nov.

Pl. X.

Black Perch.

B. 6; P. 15; V. 1/5; D. 15–12; A. 3–11; L.L. 58; L.T. 7/19.

Length three and one fifth times the height and four times that of head; orbital diameter equals half of snout and one-fifth of height of head; mouth protrusal with three imbricate rows of small teeth with blunt curved tips and a crowded belt of setaceous teeth on the inside of both jaws.

Dorsal begins behind the insertion of the pectoral and over the ventral; first soft dorsal ray is over the vent; base of the anal is less than the soft dorsal, its length exceeding by one half the height of the dorsal, which is one fourth the height of the body; second anal spine less than the third, the first being merely a slender process from the second, and not distinct in its insertion; caudal emarginate; lateral line arched; scales large, ciliate.

Colour (dried), olive-brown.

A single stuffed specimen in the Auckland Museum, labelled "Black Perch, Nelson."

Length, 16 inches.

It is a handsome fish in general form and size of scales, resembling the

kahawai (*Arripis salar*). This fish differs but little except in its proportions from *G.* (*Crinideus*) *simplex*, Rich., and is evidently closely allied to that species which frequents the east coast of Australia.

11. *Chilodactylus spectabilis*, Hutton (Cat. Fish. N. Z., p. 8), is common near the East Cape, and is called by the natives Ehouhounamu or Nanua.

11b. CHILODACTYLUS DOUGLASII. Hector. nov. sp.

Pl. X.

Native name—Porae.

B. 6 ; P. 9/6 ; V. 1/6 ; D. 18–29 ; A. 3–16 ; L.L. 63 ; L.T. 7/18.

Head three and a half times in length ; height two and a half times ; body compressed, elevated, snout produced, profile above eyes abrupt, snout three and a half times the orbital diameter; fifth and sixth and lowest pectoral rays thickened and produced to opposite the ninth anal spine, fourth lowest extends to the vent ; anterior insertion of pectoral below the sixth dorsal spine, which is the highest of the series; soft dorsal commences over the vent, is uniform but not equal to the spinous in height, and extends further back on the tail than the anal ; ventrals below the tenth dorsal spine.

Thoracic region keeled, jugular with cross folds ; lips tumid ; teeth in a single series on intermaxillaries above, and on lower maxillaries small, trenchant and deeply imbedded in a fleshy gum ; cheek scaled ; horizontal branch of operculum smooth ; head and shoulder scales minute, body scales two thirds diameter of orbit, cycloid ; lateral line curved ; stomach with a deep fundus and pyloric branch equal in length to œsophagus, four short cæca ; intestine folded three times with a distinct spleen ; a distinct rectal division of the colon with strong muscular walls ; remainder of the intestine membranous ; abdominal cavity lined with black pigment; swim-bladder large and divided into lobes ; food, small *Crustacea.*

Colour, grey or green on back and head ; dorsal blue-grey with green spots ; cheeks silvery ; gold and green patch on humerus and behind the gills ; back and sides of body green ; belly silvery ; fins steel blue.

Not a common fish, but highly esteemed as food. Caught along with tarakihi in ten to fifteen fathoms, but very local. Ngunguru Bay, north of Wangarei, and Bay of Islands, Auckland, in October. Only two caught among one hundred tarakihi.

Length, 2 feet.

I have named this fine species in honour of Sir Robert Douglas, Bart., to whose kind hospitality I was indebted for a pleasant fishing excursion at Ngunguru, which afforded me many novelties.

During the same visit to Ngunguru I obtained a mutilated fragment of the following fish, which appears to be well-known locally, but is rarely caught. I am unable to identify it with any described species.

Parore, or Mangrove Fish.

A fish 18 inches long with black bands on a dark ground; head not seen; anal short, 3–13; P. 15, all short; height equal to half the length; peritoneum black; does not take bait, but frequents rocks among the mangroves at high water. Ngunguru and Wangarei Harbours.

15a. SCORPÆNA BARATHRI. sp. nov.

Pl. X.

B. 7; P. 18; V. 1/5; D. 11–1|13; A. 3/5; Pores 22; L. scales 65; L.T. 7/20.

Length equal to three and a quarter times the height, and two and two-thirds the length of head; teeth on the palatines, vomer, and jaws in fine villiform bands; general form compressed-elongate with profile of head convex; length of snout equal to diameter of orbit, maxillary rather longer, interorbital space equals one-third the same; supraorbital ridges with five spines; Præoperculum with five spines on the lower limb; suboperculum with two appressed spines on the upper limb; third dorsal spine longest and equal to half the length of the head; anal spine of same length and greater than base of anal fin; the interval between the anal and caudal is twice that between the soft dorsal and caudal.

Colour silvery, with a yellow hue and a few brown spots on the back, and a dark patch on the dorsal fin.

Approaches nearest to *S. panda*, Rich., but is distinguished chiefly by the greater length and less height of the dorsal, and shorter pectorals.

Total length, 5 inches.

Dredged by H.M.S. Challenger Expedition in 400 fathoms, off Cape Farewell.

18a. TRACHICHTHYS INTERMEDIUS. sp. nov.

Pl. XI.

P. 16; V. 1/6; D. 6/13; A. 3/11; L.L. 28; L.T. 6–10.

Body compressed; length of head nearly equal to the height and two and a half times in the length (without caudal, which is equal in length to the head); pectoral extends behind the vent, being same length as caudal, and has the fourth lowest ray longest; ventrals slightly in advance of pectorals, and reach to the vent, which is behind the middle; snout rounded, its length being one-half the diameter of the orbit; cleft of mouth very oblique; maxillaries expanded behind and twice the diameter of the orbit in length; teeth in fine villiform bands; interorbital space equal to the orbit, prismatic, with a lozenge-shaped space on each side, separated by a double elevated ridge that terminates in two spines over the nostrils in front and diverges behind to bound an occipital space; the upper part of the head is formed of a delicate framework and membranes enclosing large cavities.

The infraorbital area is crossed by seven rays, and the operculum by two vertical ridges with five transverse bars, the lowest being prolonged over the suboperculum and angle of the gill-opening as a roughly serrated spine.

Between the occiput and commencement of the dorsal is a rough elevated ridge. The posterior dorsal rays rest in a groove. The caudal is deeply forked, each lobe consisting of ten soft rays and seven sharp spines above, and six below. The dorsal and anal fins end at the same vertical line, and the interspace to the caudal is equal to half the length of the body. The greatest height is in the vertical of the first dorsal. Dorsal begins at one-third the total length and over the origin of the ventral. The serrated ventral keel consists of ten scales.

Colour silvery white, except the tips of the dorsal fin and caudal lobes which are darkened with crowded black spots. The neck, back, and base of caudal have also a dark shade from the presence of minute spots. The scales above the lateral line are rough and adherent, but below are soft and deciduous.

Total length 2·7 inches. Height ·85.

Dredged by H.M.S. Challenger Expedition in 400 fathoms off Cape Farewell.

This fish approaches *T. elongatus*, Günth., of which a single specimen was obtained at the Great Barrier Island, but on account of its having evidently intermediate characters between that species and *T. australis*, I have distinguished it under the above name.

21A. ZIPHIUS GLADIUS. L.

Sword-fish.

Z. gladius, Günth., II., 511.

D. 3–40; A. 17; Ventral fins, none.

"The sword-shaped upper jaw much depressed and flat. Dorsal fin elevated in immature specimens. In old specimens the middle part of the dorsal and anal fins becomes very low or disappears so that there are two fins on the back and behind the vent."

My attention was drawn to a snout of this species in the Auckland Museum, which was obtained near Wangarei, to the north of Auckland. Being in that district I found on inquiry that the sword-fish was captured by the natives in Ngunguru Harbour, where it was seen swimming about in shallow water, with its dorsal fin high above the surface. The snout only was preserved, and given by the natives to Mr. McLeod, of Wangarei, by whom it was presented to the Auckland Museum. I record this statement as this sword-fish is mentioned only as an inhabitant of the North Atlantic, but is frequently brought out to the colonies and presented to museums.

24a. CARANX KOHERU. sp. nov.

Plate XI.

Native name—Koheru. The Herring Scad.

D. $7 \frac{1}{29}$ I. A. $2 \frac{1}{28}$ I.

Length of body is four and two third times the height and three and a half times the length of the head; teeth very minute in a single series on both jaws, also present on the vomer and palatine bones; cheeks smooth and bright silvery; breast scaly; lower jaw longest, maxillaries free, dependent and expanded; snout longer than the diameter of the eye; pectoral is over the ventral fin, and extends back to the vent, which is at one-half the total length, including the caudal; scales very small, being one-fifth the diameter of the eye; the lateral line is curved till under the twelfth soft ray of the dorsal, and then becomes straight, and is armed with fifty-eight keeled plates, the anterior curved portion having seventy-two serrated scales.

Colour, steel blue above, silvery beneath, with a black spot on the edge of the opercular notch.

Total length, 5·5 inches. The natives told me that the full adult size of this fish is 9 inches, and that it is found at all seasons along the coast between Wangarei and Cape Brett. I obtained my specimens among a shoal of immature hauturi (*Trachurus trachurus*) in Tutukaka Harbour, near Ngunguru.

31*b*. *Ditrema violacea*, Hutton.

Is a common fish near the East Cape and at the Bay of Islands for a few weeks in autumn, and is very much esteemed as food by the natives, who call it maomao.

31c. PLATYSTETHUS ABBREVIATUS. sp. nov.

Pl. XI.

B. 5; P. 16; V. 1/6; D. 7/26; A. 2/26; L.L. 80; L.T. 6/20;
Caudal, 3/ 14/3.

Body compressed; general form rhomboidal, the greatest height being vertical to the second dorsal spine, which is over the anal spine; length equal to one and two-third times the height, the head being two-thirds of the height; length of snout less than diameter of the orbit, which is half the length of the head; interorbital space equal to the snout, this being the greatest thickness of the body; the eyes are very high up, and over each orbit is a double serrated ridge that ends in a spine that projects forwards and covers the nostril; the inner branch of the ridge is continued backwards bounding a deep interorbital depression, the outer being continued round the margin of the orbit; the lower jaw slightly projects; the upper jaw is formed of the intermaxillaries, the maxillaries depending vertically over the

angle of the mouth and ending in a spinous process ; the inferior edge of the lower jaw is serrate ; infraorbital space scaled, the opercula naked with all the lower free edges serrate.

A strong ridge with eighteen rough scales extends from the isthmus to the ventrals. The groove for the reception of the dorsal is bounded by twenty-six oblique spinous scales, and that for the anal by twenty similar scales each having four minute spines, the first being longest.

The first dorsal spine is short, the second long, being half the length of the head. The ventral spine is the same length, the anal spine being one-third. The second dorsal spine is compressed, with a sharp anterior edge. Soft dorsal does not begin with a spine.

The length of the caudal part of the body equals the orbital diameter, and has three short pointed spines above and below the base of the caudal, which is rounded. Scales very narrow and rough. Teeth very minute.

Colour silvery, with a black crescent behind the pectoral, which is very small and rounded. There is also a black line along the base of the dorsal and anal, and a patch on the base of the caudal.

The depressed interorbital space, shorter form, and different number of fin spines are the chief characters on which this fish is separated from the only other species of the genus—*P. cultivatus*, of which only two specimens are recorded from Norfolk Island.

Total length, 3 inches.

Dredged by H.M.S. Challenger Expedition in 400 fathoms off Cape Farewell.

32. *Scomber australasicus*, C. and V., is caught in large numbers on dark nights in spring between Wangarei and the Bay of Islands, where it is known as the Tawatawa.

36d. LEPTOSCOPUS ROBSONI. sp. nov.

P. 21 ; D. 34 ; A. 39.

Length equal to seven times the height, and four times the length of the head, which is two and a half times its greatest breadth ; the eyes are lateral and equal in diameter to the interorbital distance ; teeth in several rows, with a cluster of long incurved teeth in the middle of the upper jaw, and an irregular outer row of strong incurved teeth in the lower jaw ; vomer smooth, labial cirri hardly discernible. Colour grey, spotted with light-brown, light-grey beneath.

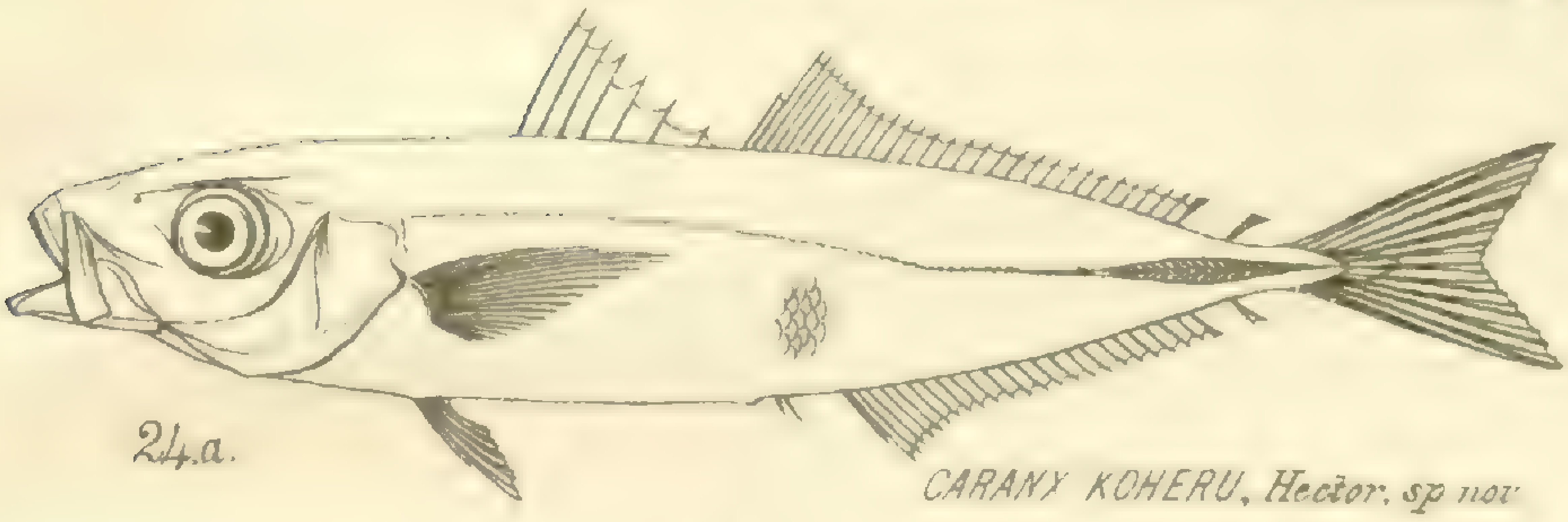
Length, 4·5 inches.

Cape Campbell. Collected by Mr. Robson, light-house keeper, in 1874.

This fish differs from *L. angusticeps*, Hutton, in the narrow interorbital space, the strong teeth, and almost total absence of cirri on the lip, but it might be the immature form of that species.

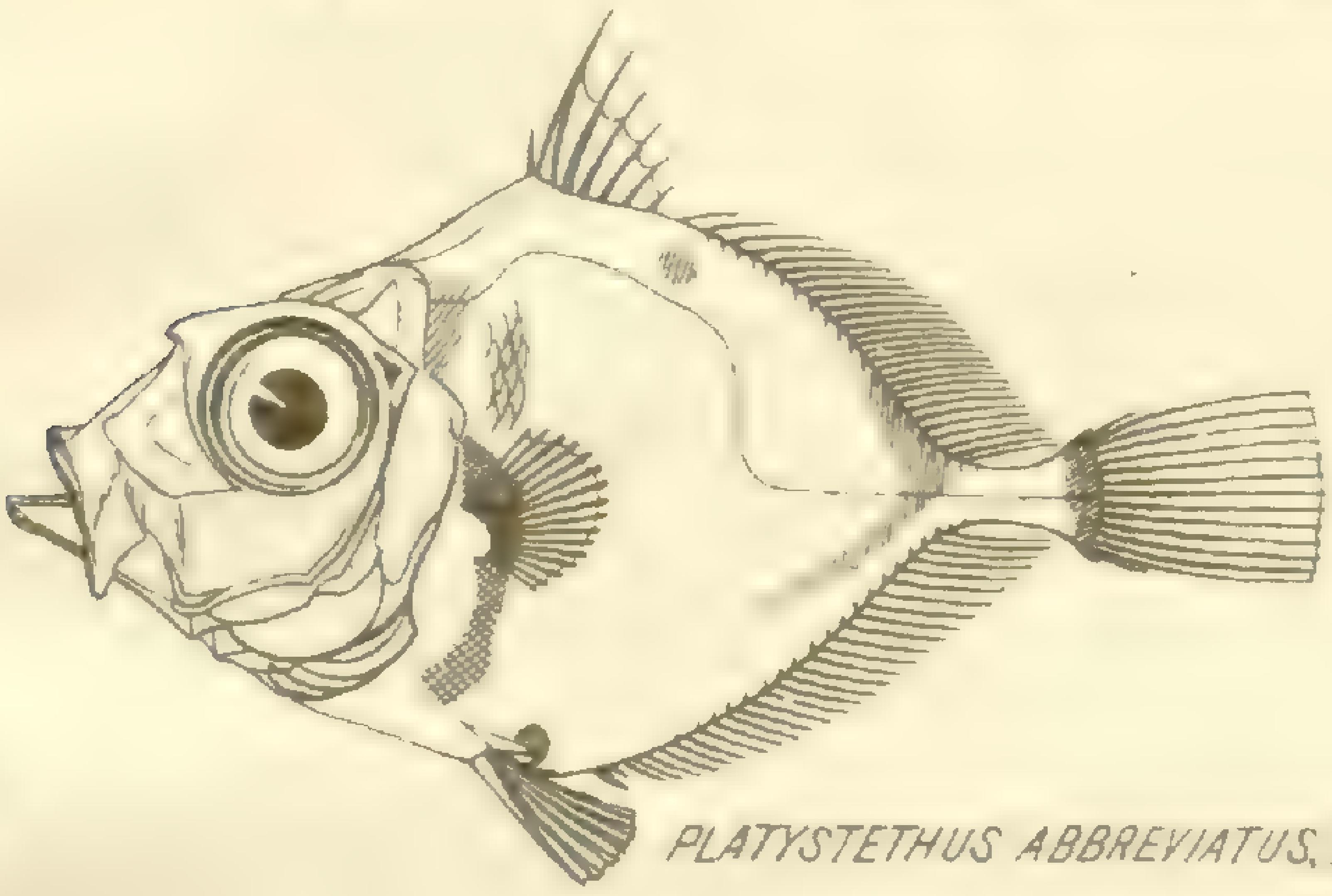
18.a

TRACHICHTHYS INTERMEDIUS, Hector, sp. nov.



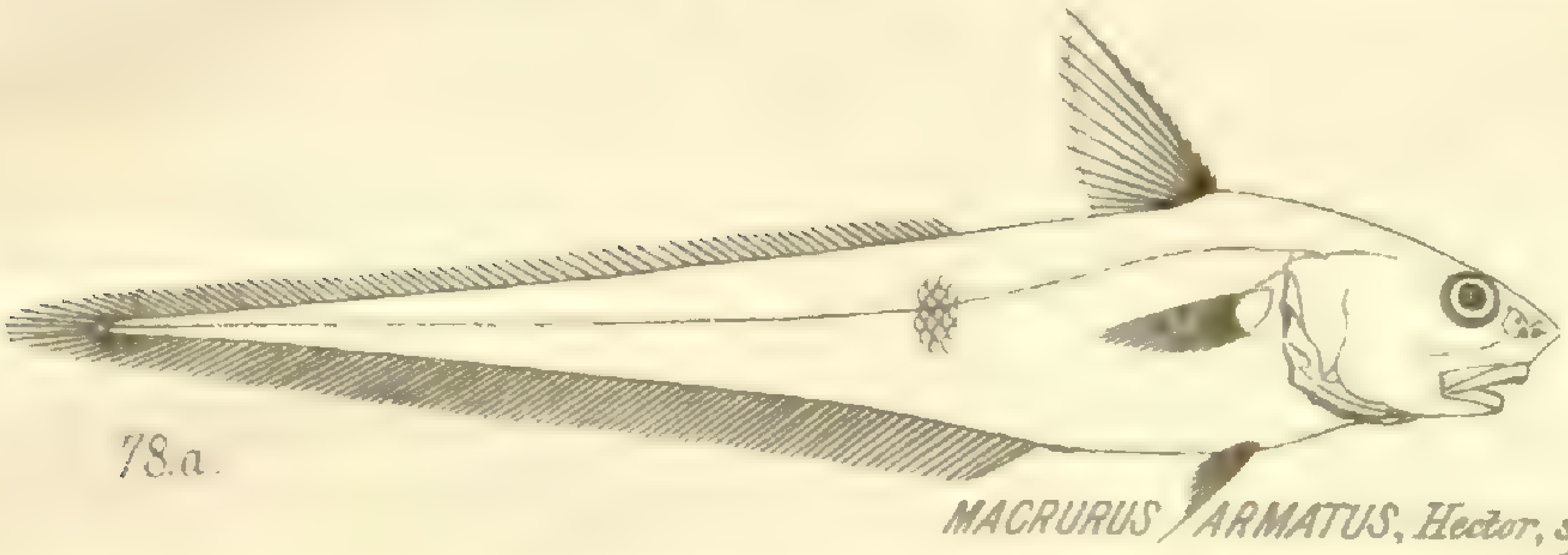
24.a.

CARANX KOHERU, Hector, sp. nov.



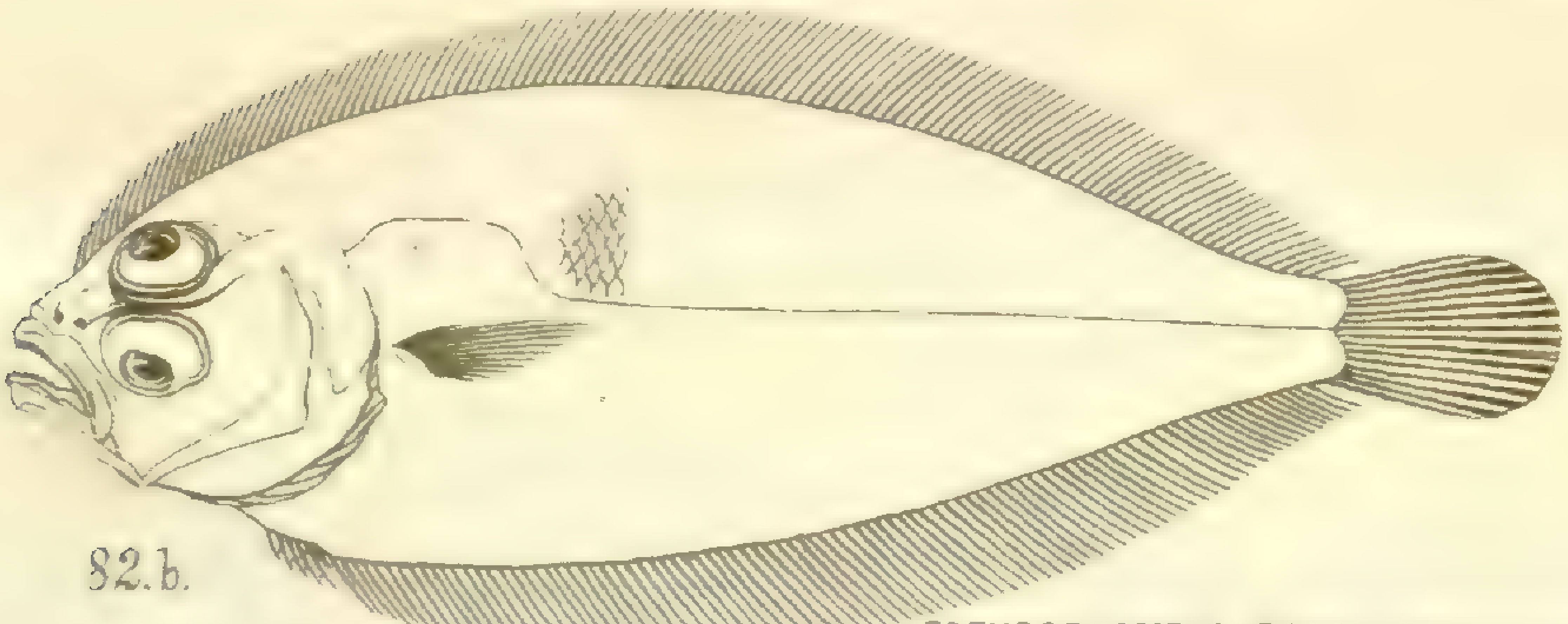
31.c.

PLATYSTETHUS ABBREVIATUS, Hector, sp. nov.



78.a.

MACRURUS ARMATUS, Hector, sp. nov.



82.b.

PSEUDORHOMBUS BOOPS, Hector, sp. nov.

90.d.

MAUROLICUS AUSTRALIS, Hector, sp. nov.

J.B. del. et lith.

66a. *Ctenolabrus knoxi*, Hutton, is common near the East Cape, and is called muritea by the natives.

78a. MACRURUS ARMATUS. sp. nov.

Pl. XI.

D. 11–75 ; A.—87 ; V. 7.

Length of head equal to half the length of the body before the anus, and five and a half times in total length ; greatest height at first dorsal ray not equal to the length of head.

Second dorsal ray as long as the height of body, spinous anteriorly and enveloped in a sheath that is prolonged as a filament—over-reaches only half the distance to the second dorsal, the interspace of the two dorsal fins being equal to two thirds the length of the head ; diameter of orbit is one fourth of the head and equal to the snout, but exceeds the projection of the snout beyond the mouth by a third ; interorbital space is one and a third of the orbital diameter ; first ventral ray is prolonged and reaches to the vent ; teeth in a single series ; mouth wide, extending across four-fifths of the inferior surface of the head ; scales, with three feeble spines, the middle spine being granulated on the head and smooth on other parts of the body.

Total length, 5 inches.

Colour uniform light grey.

Dredged by H.M.S. Challenger Expedition in 400 fathoms off Cape Farewell.

82b. PSEUDORHOMBUS BOOPS. sp. nov.

Plate XI.

B. 5 ; D. 118 ; P. 11 ; V. 6 ; A. 93 ; C. 16 ; L.L. 80 ; L.T. 36.

Eyes on left side, mouth and head otherwise symmetrical ; length equal to two and a half times the height and three times the length of head ; lateral line arched over the pectoral fin, the length of which is one third the height, and the same as that of the caudal, which is rounded ; left ventral fin in line with the anal but not continuous ; length of maxillary is two and two third times the length of head and two thirds that of snout ; orbits separated by a narrow slightly elevated ridge that overhangs the lower orbit ; dorsal fin commences in front of eye, and one half the orbital diameter from snout ; opercular margin entire, except a shallow notch in front of pectoral ; præopercular limbs join at right angles ; cleft of mouth oblique, maxillaries extending to the anterior vertical of the upper eye ; every part covered with scales, the diameter of which is one third that of the profile, with the free margin ciliate.

Teeth in a single row on both jaws in equal number, there being six on each side above and below—none on the vomer ; lower jaw with a prominent gonyx.

Colour, yellowish-white above, white beneath.

Differs from *P. scaphus*, Forst., to which it is closely related in the number of fin rays, and in the greater relative size of the head and the strikingly large orbits.

Dredged by H.M.S. Challenger Expedition in 400 fathoms off Cape Farewell.

90d. MAUROLICUS AUSTRALIS. sp. nov.

Plate XI.

The Southern Pearlside.

D. 10; A. 9 or 20.

In 1863 I found a specimen of this brilliant little fish cast up on the shore at the head of Milford Sound, and referred it to *Scopelus humboldtii*, of Yarrell, which is synonymous with *Maurolicus borealis*, according to Günther's catalogue. The specimen was unfortunately lost, but a drawing I made shows that it was the same fish as that which I have now to describe.

After comparing the New Zealand fish with the numerous descriptions and drawings, quoted in Yarrell's work on British Fishes, of various fishes now included under *M. borealis*, I admit its separation from that species is chiefly to avoid asserting so extensive a geographical range without actual comparison of the specimens.

The second specimen was found by Captain Fergusson, A.D.C. to His Excellency Sir James Fergusson, entangled in seaweed in Cuttle Cove, Preservation Inlet.

Its length is 1·5 inch.

Colour, a bright steel blue with silvery sides, and four rows of intensely blue phosphorescent spots along the ventral surface.

The height is contained four times in the length, and is less than the length of the head. The dorsal fin is set over the space between the ventrals and anal, and the adipose dorsal lobe is close to the caudal. The number of luminous dots on the different ventral lines is as follows:—On the isthmus, 4; row above the pectoral fin, 9; between the isthmus and ventral fin, 9; between ventral and anal, 5; between the vent and the caudal, 23.

The specimen formerly got in Milford Sound measured two and three quarter inches in length, and differed only in the smaller proportionate size of head and a longer anal fin of twenty rays, and this maximum length of the anal fin, which terminates below the adipose lobe, is more likely to be normal, the rays being very delicate and easily destroyed.

The habitat of this interesting little fish is the surface of the ocean, and I was informed that several specimens similar to, if not identical with it, had been taken by the Challenger Expedition with the tow net.

ART. XXXV.—*Notes on New Zealand Whales.* By JAMES HECTOR, M.D., F.R.S., Director of the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 12th Sept.*, 1874, *and* 10*th Feb.*, 1875.]

NEOBALÆNA MARGINATA. Gray, Trans. N. Z. Inst., V., 155.

Plates XVI.—XVIII.

AMONG a series of cetacean remains forwarded from the Auckland Museum for determination, I find the skull of a young calf of this species, which, notwithstanding its small size, presents the same proportions and other characters as the type specimen, the dimensions of which are given in Vol. II. of the Transactions at page 226. It measures as follows :—

	Feet.	Inches.
Total length	2	11
Greatest width	1	4·5
Length of beak from nasal bones	1	4·5
Lower jaw—length	2	4
„ vertical width	0	4
„ width at middle	0	4
Baleen—width	0	2
„ length	1	0

The beak is slender, pointed and arched, the maxillaries being very narrow in front, and covered by the inter-maxillaries, which are rounded, and form an elevated ridge that projects two inches beyond the maxillaries.

The baleen is yellowish-white, with a narrow brown margin and yellow hair.

The ear-bones agree both in character and size with the type specimen, notwithstanding the great difference in the size of the skulls, but they are not so rough on the external surface,* which is the only indication of the difference in age.

I have seen during the past year several specimens of the baleen of this whale, but never of larger size than that first described as belonging to the type obtained on the island of Kawau. It appears to be found on all parts of the coast, but is described by the whalers as of rare occurrence. One qualified informant, on examining the baleen, said it belonged to the scrag whale (*Balæna* [*Agaphilus*] *gibbosa*, Gray ?) but he may have been misled by the white colour of the baleen.

The absence of an elevated coronoid process in the lower jaw clearly separates both skulls under consideration from the genus *Agaphilus*, as described by Cope (Gray, Suppl. Cat. Seals and Whales, 1871, p. 47.)

* Trans. N. Z. Inst., V., pl. vi., 3*a* and *b*. In the letterpress the references are 1*a* and *b*, the figures having been transposed.

On 12th January I was informed by Mr. Charles Traill of the capture of a small whale near his residence on the north end of Stewart Island, and that he had fortunately been able to secure the complete skeleton. Mr. Traill states it to be a finback, but from the description which he gives, especially of the baleen, I am inclined to think that it will prove to be a specimen of *Neobalæna marginata*, and as a considerable period may elapse before the skeleton reaches the museum, I extract the following particulars from Mr. Traill's letter.

The specimen seems to be a female. Colour black, with a light stripe on the belly; length, 15 feet 3 inches; breadth of tail-flukes, 3 feet 8 inches; pectoral fins situated immediately behind the head, each being 1 foot 3 inches long, 230 plates of baleen on each side, the largest being 18·5 inches long by 1·8 inches wide at base, and 0·1 inch thick; colour of baleen, yellowish-white with a dark margin. The ribs are at least seventeen pairs, and are very oblique. Most of them are nearly straight, broad, and flat, and very small towards the point of attachment, the form being suggestive of short swords or paper-knives, and from their shape and slight curvature very unlike ribs. The sternum is singular, bearing a striking resemblance to a scutcheon, and appearing only to have had one rib attachment on each lateral border. The seven cervical vertebræ were thoroughly anchylosed.

Mr. Traill gives no other particulars respecting this interesting specimen, which was captured among a large school of black-fish, many of which were taken at the same time.

Postcript, 21st December, 1874.—The skeleton of the whale above referred to having arrived at the museum, I am able to add the following description of this cetacean, which proves to be as I anticipated, the true *Neobalæna marginata*, Gray. It will be observed that the only material difference from the information supplied by Mr. Traill is respecting the number of ribs, there being only fifteen pairs while he was of opinion that there had been seventeen pairs.

The characters afforded by the complete skeleton confirm the propriety of placing this cetacean in a separate family, intermediate between the true whales and the finners (Gray, Suppl. Cat. Seals and Whales, p. 41).

With the true whales (*Balænoidea*) it has the following characters in common:—Baleen elongate and of fine quality; chest and belly smooth; tympanic bones rhombic; cervical vertebræ anchylosed; mandibular ramus without a coronoid process.

To the finners (or finbacks)* it has the following points of resemblance:—Body elongate and slender, the proportion of head being less than one fourth

* Whalers often speak of right whales as finners or fin-fish, from their yielding baleen or "fin," as they term it.

J.B. del. et lith.

of the length; has a dorsal fin; pectoral fin lanceolate, moderate, and with four fingers; scapula elongate, with coracoid and acromion processes. Its peculiar characters are the small number of vertebræ, 44; the short mandibles and remarkably broad straight ribs with feeble vertebral articulations.

Skeleton.—A general view taken from a photograph by W. T. L. Travers, Esq., is given in plate XVI. The total length of the skeleton, making proper allowance for intervertebral substance, is 14 feet 6 inches, consisting of:

Skull	41 inches.
Cervical mass of vertebræ	3 "
17 dorsal vertebræ	35 "
11 lumbars	53·3 "
9 caudal	9 "

making a total of 44 vertebræ, of which the above measurements are given without including either apophyses or intervertebral substance.

The skull resembles exactly in its proportions the original type specimen from Kawau (Trans. N. Z. I., II., p. 26), which is 57 inches in length, and also the skull of the young individual belonging to the Auckland Museum, which is only 34 inches long. In its general form it is triangular, widest behind, gradually contracting in width to over the orbit, then suddenly to opposite the blowhole, and thence tapering gradually to the tip of the beak, which is moderately arched and only slightly longer than the brain-case. The width of the skull behind is 19 inches, at the orbits 18 inches, across the nasals 10 inches, the lower jaw having the usual proportions, being 37 inches long by 4·6 wide, with a feeble articulation and no coronoid process. The blow-hole, which is deeply excavated, is directed forwards, forming an oval expansion 4·5 by 3·5 inches; the nasal bones are oblong and 3 inches long; intermaxillaries extend beyond the tip of the beak and are 3 inches wide, including half an inch of a groove dividing them; the occipital foramen is 2 by 1·5 inch; condyles triangular and divergent, being beneath rather than lateral to the foramen, which is directed very much upwards when the skull is laid in an horizontal position; the ear-bones, as already stated, have the perfect characters of the former specimens, being rhomboidal, compressed, with a wide flattened lip and a quadrate aperture which does not extend more than half the length of the bone.

The cervical mass (Plate XVII., figs. 2 and 2*a*) consists of seven vertebræ, completely united by their neural spines, and all but the last of the tips of the lateral spines; the articular surface of the atlas is 6 by 2 inches, shallow, and divided by a ligamentous area that is wide above but narrow below; the neural spines are coalesced to form a sharp keel and a laminated plate overhanging the posterior articulation as in the common black whale, *Eubalæna* (*Macleayius*) *australis*; there is only one inferior lateral process, forming a wing-like expansion on each side, angulate in front but concave behind; the

posterior articular surface of the mass is nearly circular, and 3 inches in diameter.

The first dorsal has the neural arch incomplete, but all the other vertebræ in the middle of the column have their expanded processes largely developed.

The cervical mass has six lateral foramina and seven overlapping laminæ in the united neural spine, for which reason I conclude it consists of seven vertebral segments. Following this, the first dorsal is very feebly developed, with the neural arch open above and short styliform lateral processes. The second has a complete neural arch, but the spine is low. The lateral process is also short and slender, and like the first has no costal facet.

The third to thirteenth dorsals have articular indentations on the broad outer margin of the lateral processes, but these become gradually indistinct. This agrees with the character of the vertebral end of the ribs, those belonging to the fourteenth, fifteenth, sixteenth, and seventeenth dorsal segments tapering as if they had only a ligamentous attachment along their posterior border. This agrees with Mr. Traill's remark that the hinder ribs were set at a remarkably acute angle backwards on the vertebræ.

The transverse processes of all the vertebræ behind the second dorsal are greatly expanded and very thin; thus, that of the eleventh dorsal is 5.5 inches wide by 6·5 inches long, the neck of the process which springs from the vertebræ being only 3 inches, and the thickness of the blade of the process only $\frac{1}{8}$ inch. They occupy nearly the same place throughout in relation to the bodies of the vertebræ.

The neural spines are at first directed forwards, but at the sixth dorsal begin to slope backwards and soon become very oblique. The centra also rapidly increase in length, that of the twenty-eighth being the longest. The measurements of the centra, taken without the epiphysial disks, are as follows:—

Vertebræ.	In.	Vertebræ.	In.
1–7. Cervical mass	3·6	26. 2nd lumbar	4·6
8. 1st dorsal	·8	27. 3rd ,,	4·7
9. 2nd ,,	·9	28. 4th ,,	4·8
10. 3rd ,, (first with a rib)	1·2	29. 1st caudal (with chevron)	4·5
11. 4th ,,	1·6	30. 2nd ,,	4·2
12. 5th ,,	2·0	31. 3rd ,,	4·0
13. 6th ,,	2·3	32. 4th ,,	3·5
14. 7th ,,	2·6	33. 5th ,,	3·3
15. 8th ,,	2·9	34. 6th ,, (last neural spine)	2·8
16. 9th ,,	3·2	35. 7th ,,	1·8
17. 10th ,,	3·3	36. 8th ,,	1·5
18. 11th ,,	3·5	37. 9th ,,	1·4
19. 12th ,,	3·6	38. 10th ,,	1·1
20. 13th ,,	3·6	39. 11th ,,	1·0
21. 14th ,,	3·9	40. 12th ,,	·8
22. 15th ,,	4·0	41. 13th	wanting
23. 16th ,,	4·1	42. 14th	,,
24. 17th ,, (last rib)	4·3	43. 15th ,,	·6
25. 1st lumbar	4·5	44. 16th ,,	·3

The twenty-ninth, thirtieth, and thirty-first have a well-marked ridge on the side of the body between the lateral and neural processes, lowest on the first and ascending obliquely backwards. There are no perforations in any of the lateral processes, which disappear altogether on the thirty-sixth vertebra; the thirty-fourth and thirty-fifth are damaged; the forty-first and forty-second are wanting, judging from the graduation of their diameter; the forty-third and forty-fourth are mere "buttons," and there may have been a few more present, but if so they have been removed with the integument.

Chevron bones commence at the twenty-third vertebra, and all traces of a neural arch cease at the twenty-ninth.

The ribs are fifteen on each side. The first is single-headed, with feeble articulation, no angle, 13 inches long by 1·8 wide; the second is curved and has an expanded neck, 18 inches by 1·7; the third is bent at right angles with the neck, and has a distinct capitulum, being 27·5 inches in total length; the fourth and all succeeding are less bent, the articulation becoming feeble, while the blade of the rib expands to nearly 3 inches in width and is perfectly compressed.

The sternum is a small shield-shaped bone 4 inches by 4·2, with a small blunt keel in the middle and a single articular depression on each side. The sterno-hyoid is curved, and 11 inches long; sty.-hyoids are compressed with round ends, 8·5 inches in length.

The pelvic bones are blunt and curved, 4·5 inches long.

The scapula is a flat smooth bone without any supporting ridges on either side and with scarcely any perceptible concavity. It has both coracoid and acromion processes; the glenoid fossa is elongate-oval, 2 inches by 1·5; from the plane of the articular surface the posterior border of the bone is continued backwards in almost the same plane with only a slight curve in the outline close to the articulation; anteriorly the coracoid is strictly in the same plane as the articulation, being a feeble compressed process ·5 inch in diameter and 1·3 long; the acromion is a flat wide process, commencing 1·5 above the articulation and projecting 1·5 by 1·5 inches in width; the anterior margin of the bone is nearly at right angles to the posterior margin of the bone and is 7 inches long; the flippers are 16 inches long by 3·5 wide, with an external lateral lobe; the manus consists of four fingers, one of which is almost rudimentary and the second the longest.

MEGAPTERA NOVÆ-ZEALANDIÆ. Gray, Trans. N. Z. I., V., 156.
The New Zealand Humpback.

I have had an opportunity of observing a great many of the bones of this species, and have received two skulls at the museum. One of them, presented by Mr. E. R. Gooch, was killed and prepared by him at the Kaikoura Peninsula, and was determined at the time as being the true humpback

whale of the whalers, having the usual rounded lump or hump on the posterior part of the body. Unfortunately the other bones were not preserved, but the specimen is valuable as it has the ear-bones and the baleen attached, and its history may be relied on.

The second specimen was obtained at Porirua Harbour, on the north side of Cook Strait, and is the skull of a smaller individual, but in its proportions agrees with the Kaikoura specimen.

These skulls, which both resemble closely the skull of *Balænoptera rostrata*, as figured by Dr. Gray (Synopsis of Whales and Dolphins, 1868, pl. 2), have the following dimensions :—

	A.		B.	
	Ft.	In.	Ft.	In.
Total length	7	0	6	0
Zygomatic width	4	0	4	0
Beak from nasal bone	4	6	4	0
Width of beak at notch	2	4	2	4
,, ,, middle	1	9	1	9
Length from foramen magnum to front of edge of occipital bone	1	9	1	7
Width of intermaxillaries in front	0	6	0	6
,, ,, at blow-hole ...	0	8	0	8
Length of blow-hole aperture	1	9	1	7
,, lower jaw	7	0	6	10

The foramen magnum is 3·5 inches in vertical and 2·5 inches in transverse diameter, and is bounded by two large condyles, separated below by a deep notch 1 inch wide, each condyle being 10·5 inches long and 5 inches wide.

The brain-case is triangular, sloping, and in A. is convex, with a mesial ridge, but in B. is concave on each side of the ridge, and has a more rounded outline in front.

The maxillaries are flat and gradually tapering in front of the blow-hole; the intermaxilliaries are slightly expanded in the middle and project 6 inches beyond the maxillaries to form a sharp-pointed beak; the nasal bones are solid, triangular, shelving on each side, with a keel-like ridge on the exterior superior margin.

The lower jaws are strong, curved, solid, rounded externally, with a flat internal surface, and a conical coronoid process that projects 3 inches, and is situated 16 inches from the articular end of each ramus.

The baleen consists of 300 plates on each side, the length of the concave surface to which it is attached being 5 feet; the longest plates, which are on the middle part, are 13 inches in length and 7 inches in width at base.

J.B. del. et lith.

Their colour is either black or grey, or banded with dirty white, some of the plates being almost altogether of a light tint; each plate is fringed with coarse white hair.

PHYSALUS AUSTRALIS, Gray.

Stenobalæna xanthogaster, Gray, Ann. and Mag. N. H., Oct. 1874, p. 305.

Pl. XVIII.

On the 10th of June last a large whale, reported by the whalers to be a true sulphur-bottom, was cast ashore in Port Underwood, on the south side of Cook Strait, and an assistant (Mr. A. McKay) was despatched from the museum to secure the skeleton and take measurements.

The carcass was stranded on a rocky point close to deep water, and had to be dragged into a fresh position before it could be handled. It was so much decomposed that the skull and jaws dropped through the flesh during the removal, and on this account the external measurements are not very reliable. The whole of the skeleton was ultimately secured and placed out of reach of the tide to sweeten, the paddles and smaller bones being carefully buried.

The general form of the whale was slender in proportion to the height, the head appearing long and pointed, and the after part produced, so that the greatest girth was behind the shoulders. The throat and belly were strongly plaited with longitudinal bars of hard skin 2·5 inches wide, the interspaces having elastic skin.

The paddles appeared short in proportion to the general size, and there was a low recurved and pointed fin on the back just over the vent, and the same distance from the tip of the tail as the length of the head.

The brain-case is one third the length of the skull; the baleen slight, longer than broad, black on outside edge, shading to pure white inside the mouth. Width of base, 2 feet 6 inches.

The following measurements were obtained:—

	Ft.	In.
Total length	70	0
„ of skeleton	67	3
Length of head	19	0
Lower jaw	17	0
Occiput to last rib	14	0
Last rib to first caudal (*i.e.* vertebra with chevron bone)	16	0
Caudal series of vertebræ	18	3
Length of bones in the paddles, from the glenoid cavity ...	8	6
Width across phalanges	1	3
Distance from anus to tip of tail (penis 3 feet in front of anus)	17	0
Tip of tail to hump	18	0

	Ft.	In.
Height of hump	2	0
Length of base of hump	1	0
" shoulder-blade	5	9
Height	2	10

The stomach contained a quantity of stones. Colour black above, and yellow on the belly.

Postcript, 21st December, 1874.—A short notice of this whale was sent to Dr. Gray and published in the Annals and Magazine of Natural History, and from the character of the blade-bone Dr. Gray was inclined to make it into a new genus under the name of *Stenobalæna xanthogaster.* The drawing of the blade-bone sent to Dr. Gray and given in the paper referred to, was, however, only from a rough sketch by Mr. A. McKay, and is not like the macerated bone, several large cartilaginous prolongations included in his outline having disappeared. The correct form of the macerated bone is shown in pl. XVIII., fig. 6.

In September last Captain Fairchild of the Government steamer Luna successfully removed the whole of the skeleton from Port Underwood to Cow Bay, in Wellington Harbour, a sandy beach remote from the town; and since then all the bones except the skull, which had worked down the bank into ten feet water at low tide, have been cleaned and transferred to the Botanic Gardens. The skull, though cut into four parts, is so large that it must remain where it is until some means of removing it is available.

The following is a description of those parts of the skeleton which are available for examination :—

Skeleton.—Cervical vertebræ, free; second cervical with expanded alæform processes, with a small foramen at the base; third, fourth, fifth, and sixth with slender lateral arches; seventh, with incomplete lateral arches.

Atlas with the articular surfaces extending for four-fifths of the circumference of the central foramen, which is twice as high as wide and slightly constricted at two thirds of its height by the projection of the superior interior angles of the articular surfaces; the lower part receives the oblong odontoid process, the upper or neural arch being wider than high, and surmounted by a blunt triangular spine throwing forward a process that encloses a short anterior canal on each side of the base of the arch; the anti-basilar ligamentous groove separating the articular areas inferiorly is narrow linear, and only excavated to the depth of the cartilaginous layer; the superior lateral processes are short, solid, blunt, pointed, and feebly angulate in front; no inferior lateral process.

Axis with a rough odontoid area, but not an elevated process, surrounded by a horse-shoe shaped articular surface; centrum of this and all the

succeeding vertebræ quadrate, but wider than high; neural arches of the six posterior cervicals are thin with imperfectly developed central and lateral spines; eighth and ninth vertebræ have feeble neural spines, and the lateral processes expanded at the tip vertically; the lateral processes of the tenth and succeeding vertebræ are expanded in the horizontal plane, the tenth to twenty-second having articular facets excavated on their lower marginal surface; the first lumbar is only distinguished by having an articular facet.

Ribs fifteen, two belonging to the left side being lost; the first rib is broad and short and with a single elongated articular surface; the second and third have a strong expanded articular angle and a subcylindrical compressed capitulum; all the rest of the ribs have a blunt subquadrate articular surface; the seventh rib is longest, being more than twice the length of the first, and one-third longer than the fifteenth; the thirteenth, fourteenth, and fifteenth ribs are narrow, and irregular in outline and curvature.

The total number of vertebræ is fifty-seven; the chevron bones begin on the forty-second, and the neural arch disappears on the fifty-second; the lateral processes cease to be prominent on the forty-third, and are perforated by a foramen on the forty-fourth and succeeding vertebræ that have a lateral process.

The scapula is triangular, wider than high; the posterior edge is set at an angle of forty-five degrees to the plane of the glenoid cavity, and the anterior edge at seventy degrees; it has a strong curved and compressed acromion twice as long as a moderate pointed coracoid process, which is half the length of the fore and aft diameter of the glenoid cavity, and equal to its transverse diameter; the external surface of the scapula is rather concave, and both are marked by obscure ridges.

The humerus is stout and half the length of the fore-arm, which is equal to the length of the manus, which latter has four fingers.

The sternum is triangular with four articulations, and is attenuated posteriorly; hyoid bone is stout curved but simple. The total length of the skeleton without the skull, which measures 17 feet, is 50 feet 6 inches; the cervical region occupies 24 inches.

MEASUREMENTS.

	Ft.	In.
Total length of skeleton, without skull	50	6
Length of skull	17	0
Cervical region	2	0
Width of atlas	2	3
Height "	1	5
Width of axis	4	6
2nd vertebra, height of centrum	1	0

		Ft.	In.
2nd vertebra,	width of centrum	0	9
8th ,,	length of centrum across lateral processes ...	3	0
,,	neural canal height	0	7
,,	,, width	0	4
14th ,,	width across lateral processes	3	6
,,	length of centrum	0	8
,,	height of neural spine	2	4
22nd ,,	length of centrum	0	10
,,	total height	2	4
43rd ,,	length of centrum	0	11
,,	total height...	2	5
,,	height of neural spine	1	2
Scapula,	length	3	0
,,	width	5	0
,,	acromion	1	3
,,	coracoid	0	7·6
,,	glenoid cavity diameter	1	3

	Width. In.	Length. Ft.	Length. In.
1st rib	6	5	0
2nd ,, ...	7	8	0
3rd ,, ...	7	9	0
4th ,, ...	6	9	6
5th ,, ...	5	11	0
15th ,, ...	4	6	6
Humerus—length		1	10
Radius and ulna		2	9
Manus		2	0
Width at elbow joint		1	6
Sternum—height		1	10
,, width		1	10
Baleen (largest plate) width			10·5
,, ,, length			21·0

Baleen coarse, with strong white bristles; light slate grey with vertical bands of black, some blades nearly white, yellowish-white, and polished towards the angle of the mouth with a hard enamelled surface.

ORCA PACIFICA, Gray.

The skull of the grampus, or more properly the "killer" mentioned by Mr. Purdie in Trans. N. Z. Inst., V., p. 435, and presented to the Otago Museum by Captain Fraser has been forwarded to me for examination, and proves to have the characters that distinguish the above species as described by Dr.

Fig. 1.

Fig. 1. NEOBALÆNA MARGINATA, Gray.

Fig. 3.

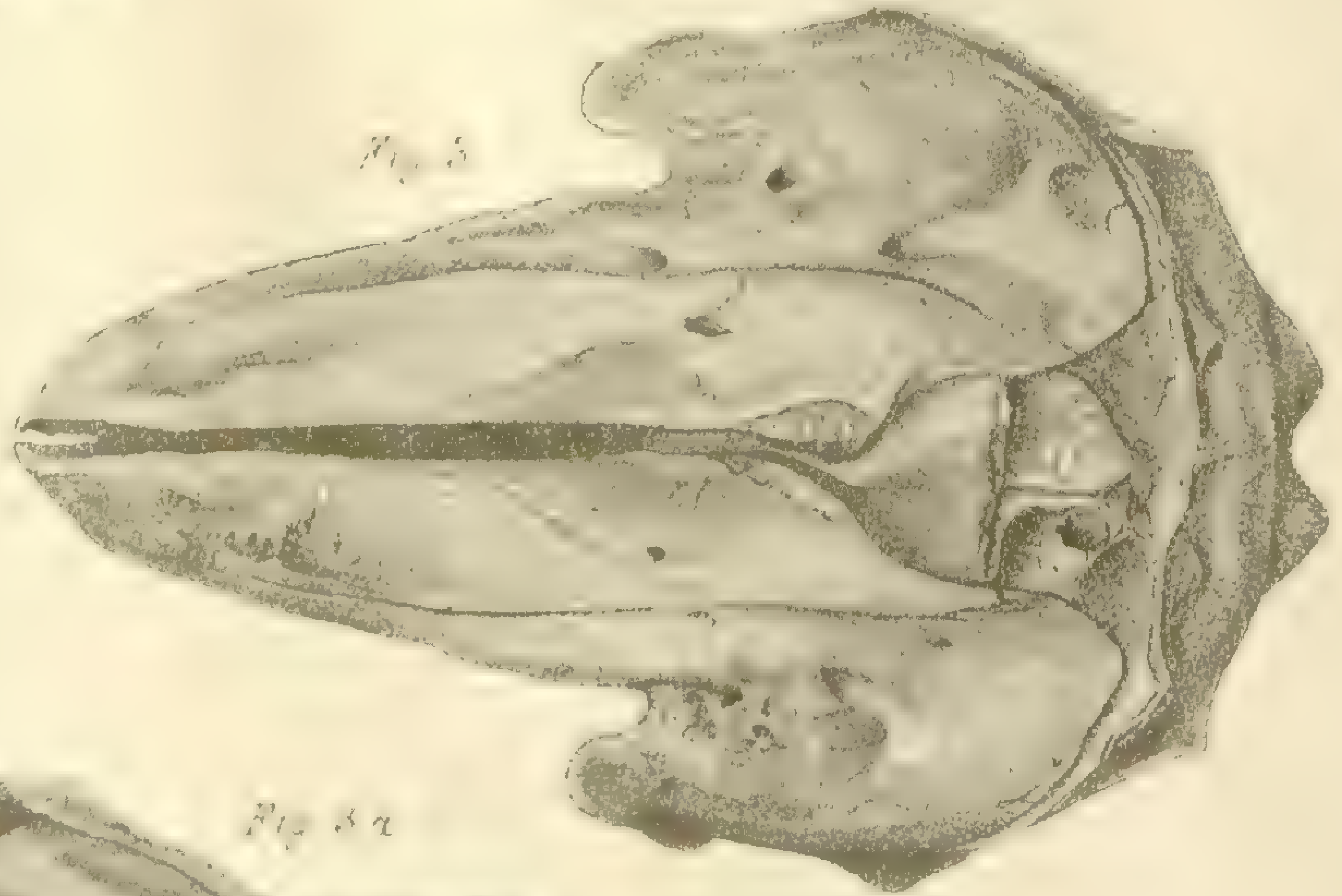


Fig. 2.

Fig. 4.

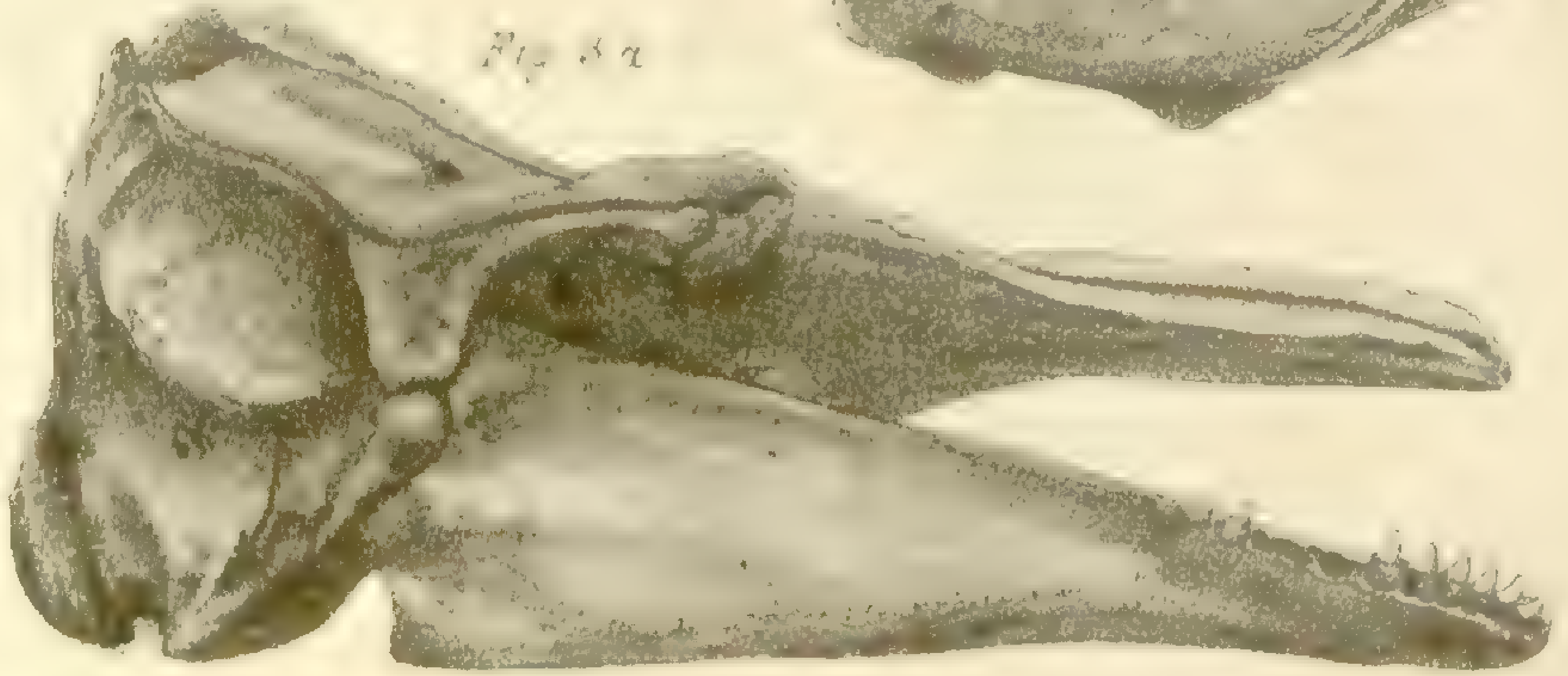


Fig. 2. ORCA PACIFICA, Gray.

Figs. 3.–4. GLOBIOCEPHALUS MACRORHYNCHUS, Gray.

J.B. lith.

Gray in the Proceedings of the Zoological Society, 1870, p. 76. It, however, agrees well with the figure of *Orca capensis* given in the Voyage of the Erebus and Terror. A reduced drawing of this specimen is given in plate XVI., fig. 2, its dimensions being as follows :—

	Inches.
Length	30·
Length of nose	15·
„ tooth series	12·5
„ lower jaw	24·
Width at notch	8·5
„ orbit	15·
Extreme width—postzygomatic	17·
Width at middle of beak	8·3
„ of intermaxillaries	3·3
Height of crest from occipital foramen	10·

A lower jaw of this same species is among the specimens from the Auckland Museum which have been submitted for determination.

GLOBIOCEPHALUS MACRORHYNCHUS, Gray.

Cat. Seals and Whales, p. 320.

Blackfish.

Two complete skeletons, male and female, of this species, were secured by Mr. Charles Traill, on Stewart Island in January, 1874, but are not yet prepared. From Mr. Traill's letter I gather the following notes of their external characters :—

Male.—Colour black, with a narrow strip of light grey running longitudinally along the belly, and expanding rather suddenly to form a large caudiform patch of the same colour under the head.

	Ft.	In.
Total length	19	0
Snout to flippers	2	4
„ dorsal fin, anterior base	5	6
„ „ posterior base	8	2
„ „ tip	8	10
„ generative organ	9	6
Length of flippers	4	1
Stretch of flukes	4	8
Female—length	15	0

The stomach was filled with the horny beaks of small cuttlefish and a few pearly eyes, probably of the same animal. There are eleven pairs of ribs and fifty-eight vertebræ ; the cervical vertebræ—seven in number—being united (?) The pelvic bones are situated about twelve inches below the line of the vertebræ.

Two skulls—young and old—of this animal are in the Auckland Museum. Drawings of the younger specimen are given on plate XVI., figs. 3 and 4.

BERARDIUS HECTORI, Gray.

Postscript, 12th January, 1875.—A complete specimen of this interesting form of ziphoid whale was cast ashore in Lyall Bay, and the following preliminary notes are given of the external form and measurements, and of the chief points of interest connected with the skeleton, which has been roughly prepared. I am indebted to Mr. H. H. Travers for informing me of the stranding of this whale, and although we were out by daylight the following morning, some mischievous boys had unfortunately been before us and had chopped off the point of the lower mandible for the sake of obtaining the teeth, and thereby injured to some extent the value of the specimen. There is no doubt, however, that in this case, as in the specimen which I described last year in Vol. VI., p. 86, as coming from the Kaikouras, the teeth were lateral and opposite the posterior edge of the symphysis of the lower jaw, and not at the tip as in the original type.

External Characters.

Male—

	Ft.	In.
Total length of body	15	6
Girth behind pectorals	7	6
Snout to eye	2	0
„ gape	1	3
„ pectoral	3	3
Pectoral—length	1	7
Snout to back fin	9	0
Back fin—height	0	9
„ length	1	0
„ anterior margin	1	4
Snout to blow-hole	1	9
Width between eyes	1	6
Diameter of eye	0	1

Tail strongly keeled. Colour, black all over.

Form very compressed towards the tail, with a strong vertical ridge on the fluke basis.

	Ft.	In.
Height of compressed body in front of fluke	1	0
Base of fluke	1	3
Length of each fluke	1	9

Posterior margin of flukes nearly straight. Genital organ directly under posterior margin of dorsal and 15 inches before the anus.

The outline is regular to opposite the dorsal, where there is a sudden

constriction or ascent in the lower profile, the vertical diameter decreasing from 4 feet 3 inches at one foot before dorsal to 3 feet.

	Ft.	In.
Pectoral extremity, length	1	6
" " width	0	6
Vertical diameter at point of beak	0	3
" " angle of gape	0	10
" " blow-hole and anterior of eye ...	1	2
" " anterior of pectoral fin	2	4
" " 6 feet	3	2
" " 8 "	4	3
" " 10 "	2	7
" " 12 "	1	8
" " 14 "	0	9
Width between pectoral extremities	1	1

Skeleton.

Length, total	15	9
Skull	2	5·5
Length of beak from notch	1	7
" " from anterior of blow hole	1	10
Width at notch	0	6·5
Orbital width	0	11
Height of occiput	0	7

Nasal septum slightly to the left side. Right side of blow-hole has a larger area for receiving the valve than the left. Nasal crest overhanging the blow-hole ; height, 3 inches. Mesorostral canal solid. Intermaxillaries much elevated. Seven cervical vertebræ, of which four or five are united. Ribs, ten. The first rib appears to articulate by its head with the last cervical, while the first seven articulate both with the lateral processes and with the centrum ; the last three with the tips of the lateral processes alone.

Dorsal vertebræ, ten ; pre-lumbar vertebræ, twelve ; the posterior of the eleventh carrying the first chevron bone. Post-lumbar vertebræ, three ; the third having the first fully developed chevron process. Caudal vertebræ, sixteen ; the last seven of which are without processes, and the first three of which have short lateral processes.

Total number of vertebræ :—

Cervical	7
Dorsal	10
Lumbar	15
Caudal	16
	48

Six ribs articulate with the sternum.

Length of sternum is 1 foot 8 inches—

	In.		Ft.	In.
1st segment being ...	9	Ribs—length of, 1st ...	1	3
2nd „ „ ...	4	„ „ 2nd ...	2	0
3rd „ „ ...	3	„ „ 3rd ...	2	2
Last „ „ ...	3	„ „ last ...	1	3
Ziphoid cartilage ...	1			
	20			

First rib curved and three inches wide at the angle; others compressed but of moderate width.

Spinous processes of first two dorsals feeble, the second being only 2 in. high; third, 5 in.; fourth, 6 in.; fifth, 6·5 in.; sixth, 7 in.; seventh, 7·25; eighth, 8 in.; ninth, 8 in.; tenth, 9in.; eleventh, 9 in.; twelfth, 9·25 in.; and the thirteenth, 10 inches.

The longest is the sixth lumbar, which is elevated fourteen inches above the floor of the neural canal.

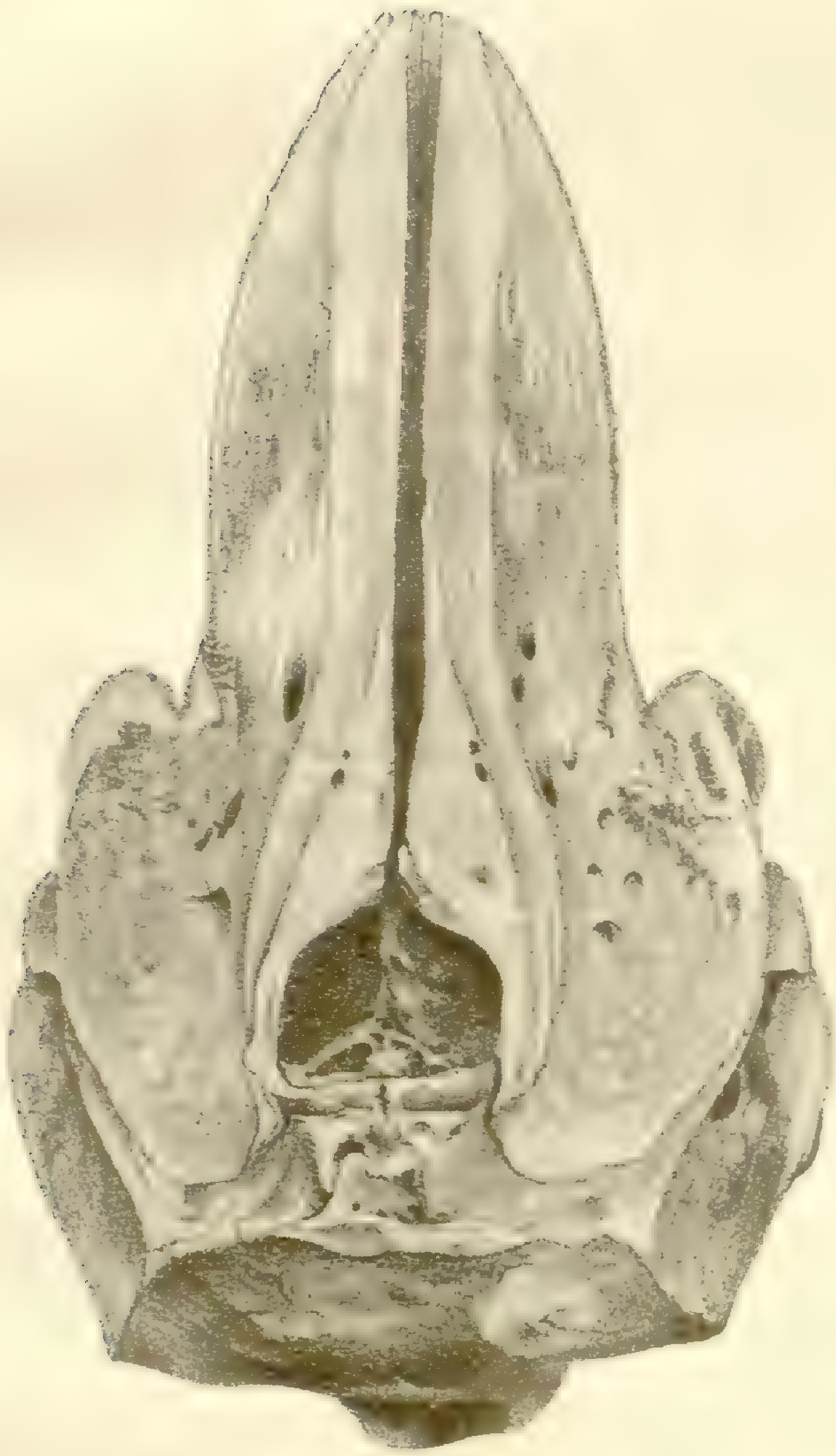
	Ft.	In.
Length of bodies of twelve dorsals	2	6
Length of anterior lumbars	4	4
„ longest lateral process, which is seventh lumbar	0	6
1st chevron bone—depth	0	1
2nd „ „	0	1·5
3rd „ „	0	3
4th „ „	0	5

The first three are rounded at the tip, and from the fourth they diminish in height towards the tail with an even continuous outline, but are inferior in length to the corresponding neural spines; the neural spine opposite the third chevron bone being eight inches high.

In the dorsal region the lateral processes are in the upper part of the dorsal centrum. In the lumbar region they spring from the middle, and are extended in a horizontal plane. In the anterior caudal region they ascend on the bodies of the vertebræ; the line of them forming an arch. The inferior portion of the centrum is compressed, so as to give the appearance of a pelvic cavity on each side of the column. Throughout the lumbar region there is a bold hæmal ridge along the lower surface of the column.

Scapula—triangular, posterior angle produced, with a wide acromion and a long narrow coracoid. Anterior angle rounded. Upper part slightly concave, the rest flat.

	Ft.	In.
Length from angle	1	1·5
Height „	1	9·



GLOBIOCEPHALUS MACRORHYNCHUS, Gray.
Adult.

	Inches.
Length of glenoid cavity	2·5
„ posterior margin	9·
„ anterior „	8.
„ coracoid	3·5 × 1·
„ acromion	4· × 1·7

The acromion is directed upwards.

The flippers are twenty-one inches from the head of the humerus.

	In.
Width at elbow-joint	4·5
„ middle of manus	5·5

DESCRIPTION OF PLATES XVI.–XVIII.

Plate XVI.—

Fig. 1. General view of skeleton of *Neobalæna marginata.* From a photograph by W. T. L. Travers, Esq., F.L.S.

2. Skull of *Orca pacifica*, side view.
3. Skull of *Globiocephalus macrorhynchus*, upper view.
3*a*. „ „ „ side view.

Plate XVII. *Neobalæna marginata.*—

Fig. 1. Skull of a calf.

2 and 2*a*. Cervical mass.
3. 1st dorsal vertebra.
6. 1st rib.
7. 3rd rib.
8. 17th rib.
9 and 9*a*. Sternum.
10. Scapula.
11 and 12. Sterno-hyoids.

Plate XVIII. *Physalus antarcticus.*—

Fig. 1. Atlas.

2. Axis.
3. 1st cervical.
4. 1st dorsal.
5. 1st rib.
6. Scapula.
7. Pectoral extremity.
8. Sternum.
9. Hyoids.

Art. XXXVI.—*Description of some Plates of Baleen in the Otago Museum.* By Captain F. W. Hutton, C.M.Z.S.

[*Read before the Otago Institute, 13th July,* 1874.]

	Inches.
Length along outer border to gum-line	19
" " " to sheath of papillæ	21
" " setose margin	31
" " inner margin to gum-line	2
" from mesial point of gum-line to extreme apex ...	25
Depth of gum	2
Width along gum-line	18

Setæ 5 to 12 inches in length, longer on the setose margin than at the apex. Colour black; texture wavy.

Inside these there are five or six rows of accessory plates decreasing in size and strongly setose.

Dr. Coughtrey informs me that it is very similar in appearance to the baleen of *Balænoptera sibaldii* of the Arctic seas.

The whale to which these belonged came ashore near Coal Point, on the south-east coast of Otago, in 1873. I was informed that it measured 109 feet in length.

Art. XXXVII.—*Description of some Moa Remains from the Knobby Ranges.* By Captain F. W. Hutton, F.G.S.; *with Anatomical Notes,* by Millen Coughtrey, M.D.

Plate XIX.

[*Read before the Otago Institute, 13th July,* 1874.]

The remarkable remains of the Moa which I have to describe were found by G. E. Allen, Esq., of Hawkdun Station, on the 4th of June last, on Messrs Campbell and Low's Galloway Station, Manuherikia district, in a crevice among mica-schist rocks, and were liberally presented by him to the Otago Museum.

Mr. Allen informs me that the crevice in question was two or three feet broad, five or six feet deep, and open at the top. The only covering the bones had was long rank grass growing up around them, and some of them were not covered at all.

The bones consist of a right metatarsus, with portions of the toes; a fragment of the left metatarsus; a right tibia; a left femur; and a fragment of a sternum. Judging by the measurements I believe them to belong to *Dinornis ingens,* Owen.

Right Metatarsus.

	In.	Lines.
Length	15	0
Breadth at distal end	5	8
Breadth at middle	2	0
Thickness at middle	1	4
Breadth at proximal end	4	6

In this unique specimen the whole of the skin and muscles of the posterior side are well preserved, while on nearly the whole of the anterior side they have gone. The bone thus exposed is bleached quite white, and the animal matter so much removed that the bone adheres to the tongue like ordinary Moa bones found on the surface, while the anterior surfaces of the trochleæ are considerably honeycombed and decayed. The hind-toe (hallux) is well preserved, being held in its position by the skin, but the horny claw covering the last joint has disappeared. Of the inner toe only the first joint remains, together with the flexor muscles. Of the middle toe the first two joints are left united with the skin of the sole of the foot, but in the second the bone is considerably decomposed. Of the outer toe all the joints are in their places, and the skin still covers the lower, outer, and part of the upper surfaces, but in this case also the horny claw is wanting, and the tip of the last joint (ungual phalanx) has decayed away.

The integument on the under surface of the toes is covered with small conical papillæ, about one-tenth of an inch in diameter at the base, which increase in size towards the sole of the foot. There is a marked protuberance under the first and second joints of the outer toe. The papillæ here are larger and closely packed together, while on the outside of the toe they are small and rounded. The surface of the integument on the upper side of the toe has been removed. On the back of the metatarsus the integument is covered by large irregular prominences nearly half an inch in diameter, divided by grooves from a tenth to a twentieth of an inch across, which are rough to the touch. These prominences are worn down quite flat, as proved by their striated surfaces, showing evidently that the Moa, like the emu, spent a considerable portion of its time with the lower surface of the metatarsus resting on the ground.

On the sides of the leg the prominences are flat, slightly lengthened longitudinally, and with a divided wart-like surface. They are about the same size as those on the lower surface, but are set closer together, and are arranged in irregular longitudinal rows. On the sides of the tibio-metatarsal articulation the prominences are smaller, more rounded, and higher. Judging from the fragment of integument left on the anterior side of the metatarsus, its surface appears to have been covered with flat, more or less rounded,

prominences in quincuncial arrangement, separated by flat smooth interspaces about a tenth of an inch wide. There is no appearance of its having been covered with horny scales as in *Apteryx*. In colour the integument is yellowish brown, getting paler on the posterior surface; while the bones, including the last (ungual) joint of the hind toe (pl. XIX., *e*), are bleached quite white.

Left Metatarsus.

Of this bone only a portion of the posterior half of the distal end remains, the rest having entirely decayed away.

Right Tibia.

	In.	Lines.
Length	27	8
Breadth at proximal end	6	1
" distal end	4	1
Circumference at middle	5	9
Fibular ridge extends down	11	5

The cartilage still extends over the lower epiphysis; but the upper articular end is quite decayed and rotten. Small lichens and *Metzgeria furcata* grow on the anterior surface close up to the cartilage.

Left Femur.

	In.	Lines.
Length	14	5
Breadth at proximal end	?	
" distal end	5	8
Circumference at middle	7	3

This bone is much decayed, and covered on its anterior side with small lichens.

Sternum.

A fragment of the right upper corner remains, showing an apparently small costal process, a rather shallow coracoid groove, and with the lateral process but slightly diverging. The whole bone seems to have been very small for so large a bird, as it by no means equals that of *Dinornis elephantopus*.

In conclusion I would remark that the extraordinary juxtaposition of decayed and lichen-covered bone with well-preserved skin and flesh seems to me to point to some peculiarity in the atmosphere which enables flesh to resist decay when shaded from the rays of the sun, and by no means to prove that the bird to which this skin and flesh belonged lived at a later date than those whose bones we now find buried under the soil.

For the following valuable notes I am indebted to my friend Dr. Millen Coughtrey.

Anatomical Notes on the Moa's Leg found at Knobby Ranges in the Province of Otago. By MILLEN COUGHTREY.

IT is the right leg, and is composed of the following bones held together by muscles and ligaments :—R. tarso-metatarsus, and bones of 1st, 2nd, 3rd, and 4th toes ; in addition a calcaneo-sesamoid bone at the tibio-tarsal joint, and a sesamoid cartilage at the metatarso-phalangeal joint.

The joints, sesamoids and muscles, even though fragmentary, in an extinct bird must be of interest, and I will therefore describe them with care.

Tibio-tarsal joint, i.e., the joint between distal end of tibio-tarsus and proximal end of tarso-metatarsus.

The ecto- and endo-condylar fossæ and the intercondylar ridge of the R. tarso-metatarsus are still covered by articular cartilage, which, though brown and dry with age, still presents distinctive characters.

The ecto-condylar fossa is as broad as long, and is shallow ; the endo-condylar fossa is longer than broad and is deep.

The margins of these fossæ are sharply defined and prominent with the exception of the posterior border of the ecto-condylar fossa, which is rounded from before backwards so as to adapt it for the shape, and to facilitate the movements on it of a sesamoid bone.* (Pl. XIX., fig. 1, *a.*)

The marginal prominence, and consequently the increased depth of the fossæ, is caused by a rim of fibro-cartilage (fig. 1, *b*) which is fused into the margin of the true articular cartilage in all parts except one, viz., the outer and posterior margin of the ecto-condylar fossa.

This separation is natural, and the free part is semilunar in form (fig. 1, *c*), bevelled from without inwards, and so contributing materially to increase the depth of the fossa at the sides in a somewhat similar way to what the semilunar cartilages act in the knee-joint of man.

This free semilunar cartilage is continuous with the sharp cartilage skirting the antero-inferior border of a sesamoid bone to be afterwards described.

Calcaneo-sesamoid bone, fig. 1, *a* :—

Its position has been before mentioned. Its general form is pyramidal, having two ends, three surfaces, and three borders.

* The difference between the two fossæ at their posterior margin may be well seen in a bone denuded of cartilage. The calcaneo-sesamoid bone is only connected with the ecto-condylar fossa. Yet it is right I should mention a curious fact observed by Captain Hutton when superintending the excavation of the Moa remains at Hamilton Swamp. He observed a leg of the Moa (probably *D. elephantopus?* or *D. crassus?*) with all the bones loose but *in situ*, and he especially noticed in this case two sesamoid bones at the tibio-tarsal joint. Bearing in mind the general positions and functions of sesamoid bones, the morphology of the tibio-tarsal joint in other birds, also the marked inarticular character of the posterior margin of the endo-condylar fossa in *Dinornis*, together with the degree of prominence and strength of the endo-calcaneal process, I should think it quite possible that the second sesamoid bone Captain Hutton saw in the Hamilton Swamp specimen was from the opposite limb, and had fallen accidentally into apposition with the other one.

The outer end is blunt and equals the base of pyramid, the inner end is acute and curved.

The inferior surface is situated between the antero-inferior and the postero-inferior borders; it is concave, and adapted for playing on the convexity of the posterior border of ecto-condylar fossa.

The anterior surface lies between the superior and the antero-inferior borders; outwardly it presents a shallow concavity, which plays on the outer half of posterior and inferior surface of the tibial trochlea, whilst its inner moiety presents a convexity which acts the part of a movable intercondylar ridge to the back part of the tibial intercondylar groove.

The posterior surface is between the postero-inferior and the superior borders, and is convex in contour. It is bare and denuded of cartilage, but presented the appearance of having at one time had a thin layer, and I should fancy from the position of the tendons to it, much bursal tissue formerly existed between it and them.

A band of dried ligament connected the posterior margin of the sesamoid bone with a depression at the back part of the intercondylar ridge of the tarso-metatarsus.

There are a few ligamentous remains attached to the apex of the calcaneo-sesamoid, but their other attachments are broken.

The tibio-tarsal bone of same side and same creature was found with the above. Its distal extremity has a thin layer of articular cartilage spread over its articular portion in a much more weathered state than that found on opposing articular surface of this joint; remains of ligaments are left in the pits on the lateral faces of the condyles, and from the more prominent tuberosity of the outer condyle a marked tuft of ligament proceeds.

These are the remains of the outer and inner lateral ligaments of the joint.

Matatarso-phalangeal joints:—

The outer toe is complete, the middle toe has its two proximal bones, and the inner or second toe has only its proximal segment. The hallux is entire but displaced from its normal position.

The posterior and inferior faces of the trochleæ of matatarsal bone are covered with articular cartilage, but the anterior faces of these trochleæ were bare, and the bone much worn and weathered (fig. 1, *d.*)

The opposing articular surfaces of the proximal phalangeal bones are covered with articular cartilage.

Strong bands of ligament (the lateral portions of the capsular ligaments) are present in the outer and middle toes on both sides, and on the outer side of the inner toe, the proximal attachments of these ligaments are to the lateral faces of the trochleæ.

The phalangeal joints were nearly complete, those of the fourth toe quite entire ; the under portions of the capsular ligaments are grooved for tendons and specially thickened.

Muscles.

a.—Gastrocnemii :—

The conjoined tendon of G. internus and G. externus is well seen, and its respective connections to the ento- and ecto-gastrocnemial surfaces still remain. The inner insertion is neither so strong nor so extensive as the outer one.

The ento-gastrocnemial insertion begins behind and below the endo-metatarsal tuberosity by a rough patch which runs into a strong ridge that ends on the posterior aspect of the inner margin of tarso-metatarsus at a point about two inches above the inner trochlea (fig. 2, *f*.)

The ecto-gastrocnemial insertion is in its upper part with greater difficulty made out, owing to its being partly covered by the hardened inflexible skin, which it was not thought advisable to disturb. It is attached to the outer border of tarso-metatarsus, and terminates in a distinct impression about three-quarters of an inch from the outer trochlea, from which it is separated by a deep but smooth groove. (This groove presents all the appearances of a vascular groove, in which an artery and a vein have formerly lain.)

The outer insertion is separated from the bone at one point to allow a tendon* to pass from the front of leg to the back ; this point is at the junction of the upper third with the lower two-thirds of bone ; but above and below this point the outer insertion is very firm and strong.

Between the two gastrocnemial surfaces a portion of the periosteum of bone is left, and the periosteum receives many fibres from the gastrocnemius at these surfaces.

There was no connection between this muscle and the sesamoid cartilage at the tarso-phalangeal joint, nor did any slip pass from the gastrocnemius to the flexor perforatus, thus differing from what has been observed in the ostrich.†

The flexor tendons ran beneath the arch formed by the conjoined tendon.

Although there is a distinct hallux (fig. 2, *a*) present, there are no appearances by which it could possibly be asserted that it had been in this case attached to the lower end of the ento-gastrocnemial ridge.

b.—Flexor Tendons of the Toes :—

These are in a very fragmentary condition.

There are distinctly four flexor tendons on the back of the tarso-metatarsal

* Can this tendon be that peculiar tendon of the Pectineus, Owen ; (or *Rectus anticus femoris* of Cuvier), fig. 1, *x*.

† Dissection of an Ostrich. A. H. Garrod, B.A., and Frank Darwin, B.A. Proc. Zool. Soc. 1872, pl. I., p. 361.

bone; of these four tendons one is a broken portion (fig. 2, *g*), a second is twisted much out of position, and its fibres unravelled (fig. 2, *h*), the other two are quite entire (fig. 2, *i*).

They can easily be divided into two sets—a posterior or superficial pair, and an anterior or deep pair.

And this is best seen where they are enclosed in an aponeurotic sheath just above and behind the tarso-phalangeal joint.

The above aponeurotic sheath being divided into two main canals, one anterior to the other, each containing two tendons, those lying in the posterior canal are the tendons of the flexor perforatus digitorum (fig. 2, *g*, *h*), those in anterior canal being the deep flexor tendons (*i*) (flexor perforans digitorum pedis), but in both cases only to the third and fourth toes.

The superficial and deep flexors to second toe will be separately described.

Between the deep flexors and the posterior surface of middle trochlea a sesamoid cartilage* is interposed; from the sides of this cartilage springs the aponeurotic archway, which has been before mentioned; the septum between the two divisions of this archway is thick and semi-cartilaginous.

The flexor tendons after being conducted by this aponeurotic sheath beyond the tarso-phalangeal joints, break up and run to their respective attachments.

The greater part of tendons of flexor perforatus end in lateral slips to the bases of proximal segments of third and fourth toes; there are second *perforated* tendons to the outer and third toe, those to latter toe being broken across.

The two tendons of flexor *perforans* respectively to the third and fourth toes each subdivides into four slender slips, which have that flattened character and imbricate relations to one another peculiar to digital tendons; the termination of those to outer toe is indistinct, except that the two deepest seem to unite and become attached to base of ungual segment, while the two superficial ones go to base of third segment of outer toe. The deep flexors of third toe are broken across opposite second phalangeal joint.

The inferior portions of the capsular ligaments of the phalangeal joints are strengthened and grooved for the passage of these tendons.

Inner or Second Toe:—

The proximal phalanx of this toe was the only part left, it was quite loose and it has to be retained *in situ* by artificial means; its external lateral ligament, however, is present.

To its base there still remain attached several tendons, and a portion of the annular ligament retains others.

It is quite clear that the superficial and deep flexors to this toe did pass through a separate and distinct aponeurotic sheath to that of the third and

* Same has been seen in ostrich. *Loc. cit.*, p. 361.

Fig. 1.

Fig. 2.

MOA REMAINS.

J.B. lith.

fourth toes. They also possessed a separate semi-sesamoid, there being a fibro-cartilaginous plate of about a quarter inch in thickness interposed between them, and the back of inner trochlea and its tarso-phalangeal joint. (Fig. 1, *e*).

From the margins of this fibro-cartilage arises the annular sheath of this digit, and this is partially divided by septæ for the tendons.

The tendons left are :—

1. About 4 inches of outer slip of flexor perforatus (fig. 1, *f*) to base of proximal bone of this toe, the stump of inner slip.

2. A small tendon enclosed in a separate sheath outside the annular ligament, and ending in the outer side of the base of this bone. It lies at the outer margin of the ligamentous substance. What it is I am unable to say. Fig. 1, *g* indicates its position.

3. Lying within the annular sheath tendons, that present two strong bundles proximally (fig. 1, *h*), but are so dishevelled and unravelled distally (fig. 2, *k*) that it is impossible to differentiate them into separate tendons, possibly deep flexors, for they are evidently the remains of tendons passing to the distal segments of this toe.

c.—Tibialis anticus (fig. 2, *i*) :—

A mere tuft of the insertion of this tendon is left, but it is clearly defined slightly below and to the side of the anti-interosseal canal, from which it is separated by a bridge of bone.

The anti-interosseal canal is large, and its bifurcation is deeply situated. fig. 1, *k*).

d.—Extensor longus digitorum pedis, (fig. 1, *l*) :—

A portion of the tendon of this muscle is left, (fig. 1, *b*), the rest of extensor group of tendons are destroyed.

Inserted into a depression beneath and in front of ecto-metatarsal tuberosity is a tendon, what it is (?) I do not know (fig. 1, *m*).

The scraps marked *n* in fig. 1 and *l* in fig. 2 indicate displaced portions of the gastrocnemii.

For a detailed account of skin and degree of decay see Captain Hutton's part of this paper.

Had the peculiar distinctness and separation of the tendons going to the second toe anything to do with peculiar motion of this digit in the Moa?

References to Plate XIX.

Fig. 1 indicates anterior aspect of specimen.

d., anterior faces of trochleæ. 1′, inner; 2′, middle; 3′, outer trochlea.

Fig. 2 indicates posterior and inner aspect of specimen.

a. hallux; *b.*, ungual segment of fourth toe; *c.*, second segment of third toe; *d.*, proximal segment of second toe; *e′.*, refers to the decayed left tarso-metatarsus.

The remaining references are distributed throughout the description.

Art. XXXVIII.—*On the Dimensions of* Dinornis *Bones.*

By Captain F. W. Hutton, C.M.Z.S.

[*Read before the Otago Institute, 12th October,* 1874.]

The large number of Moa bones exhumed last summer from the swamp near Hamilton for the committee of the Otago Museum having passed into my charge, it became necessary for me to try to determine the different species by measurement in order that I might select a complete series to be retained in the museum and ascertain what duplicates there were for exchange. In doing this I made nearly 2,000 measurements, and although I have not a sufficient knowledge of anatomy to be able to give an opinion as to what anatomical characters are sufficient to determine species, yet as the different species of *Dinornis* have necessarily been distinguished by Professor Owen chiefly by size, I think that the results of my measurements are of sufficient importance to justify my bringing them before you.

No one I think can examine such a large collection of Moa bones as I have done without being struck by the almost exhaustive nature of the researches of Professor Owen, and the collectors who supplied him with the material to work upon. It would naturally be expected that the examination of the remains of some two or three hundred extinct birds would show several forms not hitherto described. Such, however, is not the case, for with but very few exceptions all the bones can be referred with tolerable precision to some name already established, or to an intermediate form between two names. These excavations have certainly brought to light a variety of *D. elephantopus*, larger and more exaggerated in its characters than any yet recorded by Professor Owen or by Dr. Haast, and they have also proved that, so far as mere size is concerned, two of Professor Owen's species run gradually into one another. But notwithstanding this the difference in the forms he has described is so great that I am of opinion that the whole of his specific names must be retained, while one or two others may perhaps have to be added to them.*

I have already mentioned that the collection contained the remains of more than 200 birds; many of the bones, however, were not sufficiently well preserved to admit of accurate measurements being made. I therefore selected out the fully adult and best preserved bones for measurement, except where the form was represented by very few individuals, in which cases all adult bones were measured.

In the annexed table (Table A) I have arranged the various bones to the best of my judgment, according to the dimensions given by Professor Owen

* In my paper on the Geographical Relations of the New Zealand Fauna—I said that probably some of Professor Owen's species of *Dinornis* are but the young of others (Trans. N. Z. Inst., 1872, p. 232). This is a mistake, Professor Owen's species are certainly all founded on adult specimens.

(Trans. Zool. Soc., VIII., p. 371), and I have given under each heading the number of bones measured, the maximum and minimum measurements, and the mean of the whole, and it will be seen that I have arranged them under nine different species and two varieties.

Of these the remains of *D. robustus* and *D. ingens* were too few to warrant any certain conclusions, but they appear to be distinct species. *D. struthioides*, which was much more common than the other two, is very distinct and easily recognised from any other. I refer five metatarsi to *D. rheides*, but I was unable to find in the whole collection a single femur small enough to answer to Professor Owen's dimensions.

The bones that I have arranged under the name *D. didiformis* belong probably to a new species. The tibia is well marked and quite distinct, but the femur and metatarsus that I have associated with it pass almost into *D. casuarinus*, but are rather smaller.

D. casuarinus is undoubtedly a good species, easily distinguished by its tibia; but I suspect that some of the metatarsi arranged under *D. crassus* may belong to it. At any rate it is difficult to separate the metatarsi of these two species. The Otago Museum possesses a specimen of *D. casuarinus*, got at the old Botanical Gardens, Dunedin (see Hector, Proc. Zool. Soc. 1865, p. 749), which is nearly complete except the skull and right metatarsus, and there is no doubt but that all the bones belonged to the same individual. The dimensions of the leg-bones are as follows:—

	Metatarsus.	Tibia.	Femur.
Length	7·9	18·0	10·3
Circumference at middle	4·6	4·2	5·4
Breadth, distal	3·1	2·45	4·4
" middle	1·7	—	—
Thickness "	0·9	—	—
Breadth, proximal	3·7	5·15	3·5

In this case the metatarsus and tibia come under the head of *D. casuarinus*, but the femur would be referred to *D. gravis*.

D. gravis also appears to me to be a good species, although the tibia approaches very closely to that of *D. casuarinus*, but is more robust, the length being only about three and a half times the circumference of the middle of the shaft, while in *D. casuarinus* it is more than four times the circumference.* In the swamp at Hamilton the bones were so confusedly mixed together that in the whole collection I have only two leg-bones that I am absolutely certain belonged to the same bird. They belong, I consider, to *D. gravis,* although larger than those figured by Professor Owen. Their dimensions are as follows:—

* The measurements, however, given by Dr. Haast (Trans. N. Z. Inst., I., p. 86, No. 13) of bones found *in situ* in the Glenmark swamp, appear to connect *D. gravis* with *D. crassus*. For while the metatarsus would belong to the former, the tibia and femur must be referred to the latter.

	Metatarsus.	Tibia.
Length	8·25	18·5
Circumference at middle	6·0	5·25
Breadth, distal	4·9	3·0
" middle	2·33	—
Thickness, middle	1·2	—
Breadth, proximal	3·7	5·6

Between *D. crassus* and *D. elephantopus*, however, no strict line of demarcation can be drawn. It will be noticed in Table A that among the femora that of *D. crassus* is by far the most abundant, while in the tibiæ what I have called *D. crassus* var. *major* takes the lead, and among the metatarsi *D. elephantopus* occupies that position. This would naturally lead us to suspect that these three bones belong to the same species, and fortunately I am in a position to show that something like this is true. The Otago Museum possesses a skeleton of a Moa found in a limestone cave at Doctor's Creek, Waitaki, by Mr. James Stevenson. This skeleton is nearly complete, wanting only the head, a few cervical and caudal vertebræ, and two small phalanges of the outer right toe. The bones were lying in their proper position, the sesamoid bones of the ankle joints being also in their places. No hind toe nor scapulo-coracoid were found, although Mr. Stevenson looked carefully for the former. There is therefore no possible doubt but that all these bones belong to the same indvidual. The measurements of the leg-bones are as follows:—

	Metatarsus.	Tibia.	Femur.
Length	9·1	21·1	11·83
Circumference at middle	6·0	5·6	6·83
Breadth, distal	5·3	3·75	6·1
" middle	2·3	—	—
Thickness, middle	1·4	—	—
Breadth, proximal	4·15	6·3	5·1

It will be observed that in this case the femur should be referred to *D. crassus*, and the tibia and metatarsus to *D. crassus* var. *major* of Table A. The metatarsus, however, approaches more nearly to the dimensions assigned by Professor Owen to *D. elephantopus* than to those of *D. crassus*, and it is under the former name that I feel inclined to class it, as the length of the metatarsus is not quite four times the breadth of the middle of the shaft.

The divisions that I have here drawn between *D. crassus* var. *major* and *D. elephantopus* on the one hand, and *D. crassus* var. *major* and *D. crassus* on the other are, of course, quite arbitrary, and depend in the case of the femur and tibia on the circumference of the middle of the shaft, and in the case of the metatarsus on the breadth of the middle of the shaft. The divisions could have been drawn equally well in other places as the gradations are very minute and regular. I have been quite unable so far to distinguish the "clearly defined" sub-species, and even sexes of sub-species, mentioned by Dr. Haast (Trans. N. Z. Inst., VI., p. 429), and shall look forward with interest

to the publication of the measurements on which these sub-species and sexes have been founded.

In order that others may be able to form an idea of the nature and complicated character of the variations in these bones I have added a table (Table B) showing the dimensions of all the bones of *D. casuarinus* from the Hamilton Swamp that I measured. I have selected *D. casuarinus* because we know that the metatarsi and tibiæ belong to the same species, although the femora may be incorrectly associated with them. If I had taken *D. crassus* or *D. elephantopus* as an illustration the gradations would have appeared more minute and far more intricate, as my material is so much greater.

Among the metatarsi of *D. crassus* and *D. elephantopus* there are certainly two very different forms, in one of which the trochleæ are widely diverging, and in the other more longitudinal; and I tried to arrange them in two series according to the relative breadths of the distal extremity and the middle of the shaft, but the result was only to convince me more than ever of the extraordinary variation in these species of *Dinornis*, and I abandoned the attempt, as by adhering to it I should have had to depart so widely from the dimensions given by Professor Owen that my principal object in compiling Table A, viz., to show that the species *D. crassus* and *D. elephantopus*, as at present characterized, cannot be maintained—would have been lost. I also attempted to separate the tibiæ by their greater or less curvature, but this also led to the same results—a gradual passage from one to the other. Indeed the variation is so great that with over a hundred metatarsi of *D. crassus* and *D. elephantopus* lying before me, I have had very great difficulty in selecting a right and left sufficiently alike to make a presentable match.

Still, notwithstanding all that I have said, I am convinced that it will be necessary to retain the names both of *crassus* and *elephantopus* to mark both ends of the series as characterized by the proportions of the metatarsus, the length of which in *D. crassus* is more than four times the breadth of the middle of the shaft, while the length is less than four times the breadth in *D. elephantopus* and *D. gravis*. But I think that we must wait patiently for more information before we assign tibiæ and femora to them.

It may be that when these bones from Hamilton are studied by a competent anatomist he may be able to point out constant marked anatomical characters which would enable him to refer them with certainty to Professor Owen's species, and if such should be the case no one would be more pleased than I, for I think no one has been more puzzled with them; but I confess to having great doubts about it, especially as the very highest authority—Professor Owen himself—has said that he is ready and willing to yield up any of his species should intermediate sizes of femur, tibia, and metatarsus, without distinct and well-marked modifications of form or proportions be found (Trans. Zool. Soc., VIII., p. 361).

TABLE B.—DIMENSIONS OF LEG-BONES OF *Dinornis casuarinus*, OWEN, FROM THE HAMILTON SWAMP.

—	Dimensions of the Metatarsus.																				
Length	8.0	8·0	8·0	8·0	8·0	7·8	7·6	7·6	7·6	7·6	7·5	7·5	7·4	7.35	7·3	7·25	7·25	7·25	7·25	7·25	7·2
Circum. at middle ...	5·0	4·8	4·75	4·75	3·9	5·45	5·2	5·0	4·4	4·0	5·0	4·75	4·9	4·9	4·0	5·0	4·25	4·25	3.9	3·85	3·95
Breadth, distal ...	4·13	4·2	4·1	4·0	3·2	4·5	4·7	4·55	3·8	3·5	3·8	4·1	4·0	4·1	3·45	...	3·3	3·25	3·2	3·4	3·3
,, middle ...	1·95	1·8	1·8	1·75	1·37	2·0	1·95	1·9	1·7	1·5	1·85	1·75	1·9	1·9	1·5	1·95	1·55	1·55	1·4	1·4	1·45
Thickness, middle ...	1·0	1·05	1·0	1·0	0·8	1·1	1·08	1·07	0·9	1·0	1·12	1·03	1·0	1·1	0·9	1·03	0·9	0·9	0·95	0·8	0·9
Breadth, proximal ...	3·25	3·5	3·5	3·0	2·3	3·5	3·45	3·5	3·0	2·7	2·8	3·1	3·0	3·2	2·5	3·45	2·7	2·55	2·7	2·65	2·7

	Dimensions of the Tibia.													Dimensions of the Femur.						
Length	18·5	18·5	18·5	18·3	18·25	18·25	18·25	18·25	18·2	18·2	18·0	18·0	18·0	10·25	10·25	10·0	9·8	9·5	9·5	9·5
Breadth, proximal ...	5·5	5·5	5·25	5.6	5·5	6·0	5·5	5·4	5·4	5·0	5·0	5·75	5·8	4·0	3·8	3·8	3·8	3·6	3·2	3·5
,, distal ...	3·0	2·75	2·5	2·6	3·0	2·75	2·6	2·6	2·75	2·4	2·75	3·0	2·75	4·5	4·2	4·0	3·5	4·2	3·6	3·8
Circum. at middle ...	4·9	4·5	4·5	4·65	4·65	4·6	4·25	4·2	4·5	4·35	4·75	4·7	4·5	5·25	4·9	5·0	4·75	4·9	4·75	4·6

TABLE A.—Measurements of *Dinornis* Bones from Hamilton, in Otago.

ARRANGED ACCORDING TO PROFESSOR OWEN.

Dimensions of the Femur, in Inches.

	D. robustus, 2 specimens.			*D. ingens*, 8 specimens.			*D. struthioides*, 10 specimens.			*D. rheides.*			*D. didiformis?* 2 specimens.			*D. casuarinus*, 7 specimens.			*D. crassus*, 41 specimens.			*D. crassus*, var *major*. 9 specimens.			*D. elephantopus*, 13 specimens.			*D. elephantopus*, var *major*. 6 specimens.			*D. gravis*, 17 specimens.		
	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
Length	14.5	14·0	14·2	14·0	13·0	13·4	12·2	11·0	11·5	...	...	...	9·0	9·0	9·0	10·25	9·5	9·83	13·0	11·0	12·2	15·0	[illegible]	12·7	13·3	12·2	[illegible]	12·7	12·0	12·4	12·0	10·0	11·4
Breadth, proximal ..	5·5	5·0	5·2	5·3	4·8	5·0	4·4	4·0	4·1	..	..	...	3·4	3·25	3·3	4·0	3·2	3·7	5·5	4·0	4·7	5·0	6·0	5·9	5·5	5·0	[illegible]	[illegible]	5·0	5·4	4·7	4·1	4·5
,, distal ...	6·0	5·4	5·7	5·8	5·2	5·4	4·8	4·0	4·4	..		...	3·5	3·5	3·5	4·5	3·5	3·9	6·0	4·5	4·9	6·7	5·0	5·6	6·5	[illegible]	[illegible]	7·0	6·0	6·5	5·3	4·2	4·8
Circumference at middle	8·0	7·5	7·7	7·25	6·7	6·9	5·75	5·6	5·65	..		..	4·8	4·7	4·75	5·25	4·6	4·9	7.0	6·2	6·6	7·3	7·1	7·2	8·0	7·5	7·5	8·6	8·4	8·5	6·0	5·6	5·9

Dimensions of the Tibia, in Inches.

	2 specimens.			2 specimens.			9 specimens.			1 specimen.			7 specimens.			13 specimens.			6 specimens.			42 specimens.			17 specimens.			2 specimens.			12 specimens.		
Length	30·5	30·5	30·5	28·0	28·0	28·0	23·5	20·7	22·4	..	..	17·0	15·2	14·5	14·8	18·5	18·0	18·3	19·5	19·0	19·25	22·5	19·0	20·6	24·5	20·7	21·9	[illegible]	21·7	22·7	18·5	16·75	17·5
Breadth, proximal ..	7·5	7·5	7·5	7·0	7·0	7·0	5·7	5·2	5·5	.	...	5·25	4·5	4·2	4·3	6·0	5·0	5·5	6·25	5·5	5·7	7·6	6·0	6·8	8·0	6·5	7·1	[illegible]	7·5	7·8	6·5	4·5	5·5
,, distal ..	4·4	4·4	4·4	3·75	3·75	3·75	3·0	2·75	2·9	..	..	2·5	2·5	2·0	2·2	3·0	2·6	2·8	3·0	2·5	2·75	3·6	2·75	3·1	4·0	2·0	[illegible]	4·0	2·7	3·6	3·25	2·5	2·6
Circumference at middle	6·65	6·65	6·65	5·9	5·7	5·8	4·9	4·45	4·6		—	4·2	4·1	3·6	3·85	4·9	4·2	4·54	5·0	4·5	4·7	5·9	5·0	5·5	[illegible]	6·0	6·2	[illegible]	6·7	6·7	5·4	4·5	4·8

Dimensions of the Metatarsus, in Inches.

	2 specimens.			6 specimens.			18 specimens.			5 specimens.			6 specimens.			21 specimens.			16 specimens.			28 specimens.			16 specimens.			8 specimens.			12 specimens.		
Length	15·75	15·75	15·75	15·0	14·0	14·7	12·5	10·25	11·5	9·5	8·75	9·0	7·25	6·6	6·8	8·0	7·2	7·55	8·75	8·25	8·4	9·9	8·5	9·3	9·9	8·25	9·1	9·5	8·5	8·9	8·25	7·35	8·0
Circumference at middle	6·25	6·2	6·2	5·9	5·45	5·6	5·1	4·0	4·6	5·0	4·8	4·9	4·0	3·75	3·9	5·45	4·0	4·6	5·5	4·5	4·8	6·55	5·25	5·8	7·4	6·1	6·5	7·5	7·25	7·4	6·2	4·85	5·9
Breadth, distal	6·25	6·2	6·2	5·7	5·45	5·5	5·0	4·3	4·6	4·75	4·1	4·2	3·2	3·1	3·2	4·7	3·2	3·8	5·0	3·8	4·2	5·8	4·4	5·0	6·0	4·8	5·5	[illegible]	5·2	5·9	5·2	3·95	4·5
,, middle ...	2·25	2·2	2·2	2·1	1·9	1·95	1·9	1·5	1·7	1·8	1·75	1·77	1.45	1·25	1·4	2·0	1·37	1·6	2·1	1·7	1·8	2·3	2·15	2·25	2·8	2·35	[illegible]	[illegible]	2·3	2·9	2·3	1·35	2·0
Thickness at middle ...	1·5	1·5	1·5	1·6	1·3	1·42	1·25	1·0	1·15	1·2	0·95	1·12	1·0	0·78	0·8	1·12	0·8	0·9	1·2	0·9	1·0	1·5	1·1	1·2	1·7	1·2	1·1	[illegible]	1·3	1·4	1·25	1·0	1·1
Breadth, proximal ...	4·75	4·7	4·7	4·5	3·9	4·3	3·65	3·2	3·3	3·75	3·3	3·5	2·5	2·25	2·45	3·5	2·3	3·0	3·95	3·0	3·3	4·7	3·5	4·0	4·9	3·9	[illegible]	4·5	4·3	4·4	4·0	3·1	3·5

ART. XXXIX.—*Description of two new Species of* Aplysia.

By Captain F. W. HUTTON, C.M.Z.S.

Plate XXI.

[*Read before the Otago Institute, 14th September,* 1874.]

Aplysia brunnea, sp. nov.

ANIMAL of a uniform rich dark brown, about 4 inches in length. *Shell* horny, ear-shaped, firm, the whole shell very finely concentrically striated ; epidermis pale brown.

Length, ·9 in. ; breath, ·7 in.

Habitat—Wellington and Dunedin.

The shell somewhat resembles that of *A. excavata*, Sow., from Port Jackson, but it is not square at the end.

Aplysia venosa, sp. nov.

Animal yellowish-brown, veined with dark brown, about 6 inches in length. *Shell* membranous ; the apex rather coarsely concentrically striated, the rest of the shell smooth and polished ; epidermis pale straw colour.

Length, 1·25 ; breadth, 1 inch.

Habitat—Wellington.

ART. XL.—*Description of two new Species of* Crustacea *from New Zealand.*

By Captain F. W. HUTTON, C.M.Z.S.

[*Read before the Otago Institute, 12th October,* 1874.]

SESARMA PENTAGONA.

CARAPACE subquadrate, smooth, broader than long ; anterior lateral margin with two teeth ; front nearly vertical with four rounded projections ; lateral regions obliquely striated ; a pentagonal mark in the centre, the apex prolonged to the front, which it divides. Area on each side of the mouth below with moniliform transverse striæ. Arms trigonal, striated on the outside ; hands smooth outside, and with a few scattered granules inside ; fingers smooth. Legs with the third joint very broad, compressed, acute above, and armed with a single tooth at the apex, smooth ; outer joints and claws tomentose.

Length, ·67 inch ; ratio of length to breadth, 1/1·27.

A single specimen in the Colonial Museum, Wellington.

Locality not stated.

PALINURUS EDWARDSII.

Male.—Carapace beaked, armed with spines and large oval depressed tubercles separated by rows of short hairs. Beak small, compressed, curved

upwards, and with two small spines at its base. Spines on each side of the beak compressed and smooth. Abdomen transversely sulcated, and covered with flat tubercles, each segment with a row of short hairs on its posterior margin. A single tooth on the posterior margin of the lateral lobes of the abdominal segments. Anterior legs with a strong spine on the inferior margin of the second and third joints; none on the penultimate joint. The superior margin of the distal extremity of the third joint of the last four pairs of legs armed with two spines, a smaller one in front of the larger.

Length from beak to end of telson, 9·5 inches.

Colour.—Carapace dark brownish-purple; abdomen the same, marbled with yellow; legs and caudal appendages reddish orange, more or less marked with purple.

In the *female* there is a spine on the inferior margin of the distal extremity of the penultimate joint of the last pair of legs.

Locality—Otago Heads. Common.

This species differs from *P. lalandii* in its much smaller size, in the shape of the beak, in having no spine on the penultimate joint of the anterior legs, and in having a second small spine at the distal extremity of the third joint of the last four pairs of legs. I have named it in honour of M. Alphonse Milne-Edwards, who has done so much to increase our knowledge of New Zealand carcinology.

Art. XLI.—*Description of a new Species of* Actinia.

By Professor M. Coughtrey, M.D.

[*Read before the Otago Institute, 14th September*, 1874.]

Actinia thompsoni, sp. nov.

A lateral grower.—Body, 1 inch long; striped vermilion and whitish-yellow, nearly all red, striæ entire; peristomic rim wide; tentacles round on trans. sect., conical in general form, half-inch long; shafts yellowish-white, tips purple, latter slightly shaded off as it passes into the shaft of tentacle, in three alternate rows of about twenty each.

At very low water, Deborah Bay, Port Chalmers, rocks.

Two others, one pale, half-inch long; striped vermilion-red and white; tentacles not tipped with purple; the other like *A. mesembryanthemum* of Britain.

Named in honour of Captain Thompson, harbour-master.

ART. XLII.—*Notes on the New Zealand* Hydroideæ.

By MILLEN COUGHTREY.

Plate XX.

[*Read before the Otago Institute, 28th May,* 1874.]

THE following notes may be of use to co-workers in this department of zoology.

The pleasure derived from the study of these creatures has more than repaid me for the labour expended on them, and I trust the following descriptions, accompanied by the illustrations, may lead others to enjoy the same pleasure.

Many friends have assisted me in obtaining material, none more so than Captain F. W. Hutton, who kindly placed at my disposal his type collection and lent me some specimens he had recently collected ; these, with many others gathered during healthy and enjoyable rambles, have been carefully compared with one another, and with the original descriptions. Several new species have been added, some old ones have been reduced to varieties, and the descriptions of the remaining species amplified wherever it seemed to me necessary.

The works at my command have been :—

Captain Hutton's paper on the New Zealand Sertularians, Trans. N. Z. Inst., Vol. V., 1872.

Johnston's British Zoophytes, Vols. 1 and 2.

Gray's Catalogue in Dieffenbach's New Zealand.

Monograph on Gymnoblastic Hydroids, by Professor Allman.

I regret the absence of Hincks' British Hydroid Zoophytes.

Sub-order—SERTULARIDÆ.

" Hydrosoma fixed plant-like, horny, variously branched ; polypites hydraform, sessile, protected by hydrothecæ, and connected by a cænosarc, never terminal ; reproductive organs contained in horny deciduous cells scattered over the hydrosoma." Medusoids always fixed.

Genus *Sertularia.*

Sertularia johnstonii, Gray, Dieff. N. Z., II., p. 294.

This widely distributed species does not agree with *Sertularia rugosa*, Johnst.*, nor with *S. patagonica*, D'Orbigny. In the description given by Captain Hutton, some of its chief characters are omitted, and I therefore substitute the following description :—

Hydrophyton lax and delicate ; hydrocaulis spreading dichotomously

* Brit. Zooph., Vol. I, p. 164.

and sub-pinnately branched; branchlets distant and alternate, both sub-flexuous; pale yellowish brown.

Hydrothecæ distant and alternate, proximal ones nearer to one another than distal ones, variable in size, conical and sub-conical in form.

Mouth tridentate, teeth obtuse, two teeth external and lateral, one tooth internal (latter sometimes most acute and split so as to resemble two teeth).

Gonangia nearly sub-pedicellate, ovate, transversely ridged, ridges vary in number and strength, distal ones generally strongest; some truncated, others with a neck; necks two kinds, in one lips of mouth everted and neck infundibuliform, in other neck simply tubular.*

Habitat.—Attached to pebbles or fronds of seaweeds, Lyall Bay, North Island; West Coast and East Coast of South Island (F. W. H. and M. C.) Figs. 1—5.

Sertularia sub-pinnata, Hutton.

I believe this to be simply a dried variety of *S. johnstonii.*

Sertularia delicatula, Hutton.

Seems to me to be an uncommonly well defined variety of *S. johnstonii*, but in my opinion has not sufficient differential characters for founding a new species.

It is very lax and delicate; the hydrothecæ are of the long and distant variety. I failed to observe any toothing in the crowns of the gonangia. I fancy this must have been the result of drying.

Sertularia monilifera, Hutton.

Captain Hutton's description is an excellent one.

"Hydrophyton strong, erect, dichotomously branched; pale brown. Hydrothecæ alternate, crowded, tubular, the upper half slightly recurved; arranged in several rows on the main stems, but in two rows on the branches; aperture entire, or with two obtuse teeth. Gonangia ovate with strong moniliform cross ribs, and with an entire edged tubular crown."

The hydrothecæ on main stem are adnate in their proximal half, while those on branches are more free; the former are more tubular than the latter.

The appearances presented by those on main stem simulate somewhat the generic characters of a Thuiarian.

The strong moniliform cross ribs of the gonangia are numerous and very close to one another. The general form of the gonangium is markedly ovate.

Habitat.—Lyall Bay, on shells (Hutton). Figs. 6 and 7.

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* Gonangia, in most of my Timaru specimens, were truncated, the transverse ridges were absent from proximal half of gonangia, the hydrothecæ large and the teeth boldly obtuse. Between each pair of hydrothecæ is a semi-oblique joint, which, though faintly marked in the type, is well marked in the varieties (see fig. 2).

Sertularia simplex, Hutton, *loc. cit.*

Hydrophyton small. "Hydrocaulis short, simple or rarely branched, erect; pale yellowish brown. Hydrothecæ distant, alternate, ovate; aperture sinuated. Gonangia ovate, transversely wrinkled with a toothed crown."

To Captain Hutton's description I would add the following :—Hydrocaulis twisted between each hydrotheca, and the oblique joint is nearest to the proximal hydrotheca. Hydrothecæ large, swollen at base, mouth quadridentate, teeth diagonally placed, outer and inner ones more acute than lateral ones. Gonangia very indistinctly transversely wrinkled, the most distinct one being that which separates the body of gonangium from the neck.

I have not the least doubt that this species is the New Zealand representative of *Sertularia polyzonias* of Linnæus. The largest specimen I have seen is Captain Hutton's type specimen, but I have gathered innumerable dwarf specimens on the Timaru beach, around Tairoa Head, Otago, and attached to the roots of washed-up Laminarians on the Ocean Beach, and these have exhibited considerable variety. Thus fig. 8 indicates the type specimen; fig. 9 shows the characters of a very common variety I got at Timaru and on the Ocean Beach, in which the faint shallow grooves, generally three in number, that cross the hydrothecæ are well seen; fig. 10 exhibits a marked variety that I got at Tairoa Head. It is remarkably like variety *c* figured by Dr. Johnston (*loc. cit.*, Vol. I., p. 62), and presents almost distinct enough characters to form a separate species, but beyond the difference in the hydrothecæ, it agrees both in form and habit with *Sertularia simplex.*

Captain Hutton obtained his type specimen in Lyall Bay, so that this must be a very widely distributed species. I ought to add I have found variety (fig. 10) also at Tairoa Head and other places. Figs. 8–11.

SERTULARIA RAMULOSA, sp. nov.

S. fasciculata, Coughtrey (M.SS.)*

Hydrophyton creeping, several twisting around one another to form bushy tufts. Colour pale yellow.

Hydrocaulis delicate and flexuous, it and branches jointed; branchlets mostly from one side of rachis or the branches, dividing dichotomously in a sub-fasciculate manner, or in a loose racemose arrangement.

Hydrothecæ opposite a joint between each pair but nearest to the proximal pair, semi-adnate, lip oblique, and toothed, teeth two, almost lateral, one much larger than the other.

Gonangia obovate, pedicellate, attached to the open angle between hydrothecæ and ramus, smooth with a distinct neck, and mouth entire.

Hydrorhiza indistinct.

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* I first described this under the name of *S. fasciculata*, but at Mr. Kirk's suggestion changed it to the above.

Habitat.—Chiefly in upper harbour, Dunedin, festooned from rock to rock, or between branches of a dead floating tree. A few scattered specimens on Timaru beach. Figs. 12 and 13.

SERTULARIA TRISPINOSA, sp. nov.

Hydrophyton bushy, not creeping, arising in tufts from a spongy-looking hydrorhiza.

Hydrocaulis very delicate, pale silvery yellow, dichotomously branched, and subdivided.

Hydrothecæ opposite, distant, tubular, lip oblique, toothed, teeth three, one internal, other two external and lateral, of latter one much larger than the other.

Gonangia obovate, sessile, smooth, with a small process on each side near the top; a short neck.

Habitat—According to variety.

I hesitated for some time before founding this species, since it resembles in so many respects *S. ramulosa* and *S. bispinosa*, indeed it is remarkably intermediate between these two species. An ordinary observer seeing one of these varieties on the beach, rolled up in the way it is generally found, would be very apt to mistake it for *S. ramulosa*, and its colour and delicate nature would further assist in the deception. The opposite cells, the inequality of the lateral teeth, and the difficulty there is in defining the internal tooth, also simulates *S. ramulosa.*

In the acuteness of the teeth, in the form of the gonangia, in its general habit, and in the absence of parasitical polyzoa, it resembles a very lax and delicate form of *S. bispinosa.* I have got large quantities of this variety, and have noted, wherever I found it, absence of polyzoa, and large number of gonangia it bears. This variety is attached to delicate shells, also rarely in single tufts to stems of *Boltenias.—Variety a.*

Variety b is never so long and lax as var. *a*; more brown in colour; equally free from polyzoa, and rarely has gonangia, the branchlets generally lean to one side and close somewhat like a Plumularian. Figs. 14 and 15, *a* and *b*.

Sertularia bispinosa, Hutton.

Dynamene bispinosa, Gray.

" Hydrophyton long, lax, and strong. Hydrocaulis sparingly dichotomously branched, pale brown.

" Hydrothecæ opposite, tubular; aperture obliquely truncated and with two strong teeth on the outside. Gonangia urceolate, smooth, with a small tooth on each side at the top.

"*Habitat.*—Lyall Bay (F.W.H.), on shells, etc., abundant." Very widely distributed. (M.C.)

The gonangia of this species are variable as regards the teeth. Some have no teeth, others have asymmetrical teeth—thus the tooth will be well developed on one side, whilst on the opposite it will be simply a slight mammilloid elevation; others again have well marked teeth. Figs. 16, 17, and 19.

Sertularia abietinoides, Hutton.

Dynamene abietinoides, Gray.

"Hydrophyton erect. Hydrocaulis pinnately branched; pale brown. Hydrothecæ crowded, sub-opposite, tubular, slightly incurved; aperture surrounded with about five acute teeth. Gonangia urceolate, smooth, with a long blunt process (tooth) on each side at the top.

"*Habitat.*—Lyall Bay (F.W.H.) Abundant." Very widely distributed; attached to sponges, stones, shells, and peduncles of *Boltenias*. (M.C.)

To this excellent description I would add:—The hydrorhiza consists of an open fibrous network which spreads itself over the object to which hydrophyton is attached, and gives off from its upper surface the branches whose general appearance is like a bunch of open feathers. The gonangia are generally found in clusters at the lower part of the branches. In some specimens the branches throughout are short and simply pinnate, in others they are long and bipinnately divided; in the latter the hydrophyton has a lax and pretty appearance.

Apertures of hydrothecæ generally average six teeth. (Figs. 18—20, and 16.)

Sertularia fusiformis, Hutton, *loc. cit.*

"Hydrophyton lax. Hydrocaulis simple or sparingly branched, rather large. Hydrothecæ alternate, rather close, long; aperture obliquely truncated, and with two round teeth on outer side. Gonangia fusiform, large, smooth, pointed at the apex."

I would add to the above:—Hydrothecæ with tumid inverted lips. Gonangia with a marked spathulate bar or crest along its outer side.

Habitat.—Lyall Bay. On Fuci very common. (F.W.H.) Figs. 21—23.

Genus *Synthecium*, Allman.

Chief generic characters.—Hydrothecæ sessile and opposite or decussate, inner faces of each pair nearly joined together, being only separated by a thin film of cænosarc, a marked joint between each pair.

This genus was founded by Professor Allman on a remarkable specimen in Mr. Busk's collection, and this specimen he named *Synthecium elegans*. I prefer at present to give Professor Allman's own words:—

"It is a typical Sertularian whose gonosome presents the hitherto unprecedented character of having its gonangia borne on peduncles which spring from within the hydrothecæ.

"The gonangia are oval, opening at their distal extremity by a tubular orifice and ornamented by curved ridges, which terminate at each side in a zigzag line, which runs down the middle of the gonangium walls from the summit to the base. Each gonangium is borne on a long cylindrical peduncle which springs from the bottom of a hydrotheca, in which it occupies the position of a hydranth.

"The peduncle extends through the whole length of the hydrothecæ, and as it nearly equals it in diameter, it almost fills its cavity. It is covered by a delicate chitinous perisarc, and immediately on emerging from the cavity of the hydrotheca carries the gonangium on its summit.

"Whether those hydrothecæ from which the peduncles of the gonangia emerge ever carried hydranths, which subsequently became replaced by the gonosome, or whether they have been all along exclusively devoted to the gonosome, it is impossible to determine from dead and desiccated specimens.

"At all events it is certain that there is not a single point either in position or in form by which these gonangia-bearing hydrothecæ differ from the others.

"The hydroid thus is very exceptionally constructed and must constitute the type of a new genus and species to which the name of *Synthecium elegans* may be given."*

In a specimen of this obtained among other objects on the oyster beds at Stewart Island I had not the good fortune to discover any gonangia, but it enables me to add to the above description. Hydrocaulis *short* and dichotomously divided. Hydrothecæ tubular, smooth, curved outwards, aperture entire, a marked constriction in hydrocaulis between each pair of hydrothecæ. Professor Allman does not give the special part of New Zealand from which Mr. Busk's specimen was obtained; I am indebted for the Stewart Island specimens to Mr. Street. Figs. 24 and 25.

Synthecium gracilis, sp. nov.

Hydrophyton consisting of very small branches growing from a creeping hydrorhiza; pale brown in colour.

Hydrorhiza delicate, filiform, open, network creeping over fronds of delicate seaweeds, sending up branches to the height of one-eighth or one-fourth of an inch—seldom higher. *Branches* markedly erect, simple, highest having only about ten pairs of hydrothecæ, majority only about seven pairs, terminating in a slight tumescence at open angle between distal pair of

* G. J. Allman, Gymnoblastic Hydroids, p. 229.

hydrothecæ ; constricted between each pair of hydrothecæ, and then swelling gracefully out to support the next pair, giving the appearance of the lower half of body of a vase and the constricted neck of pedestal supporting it. A small cone-like projection can be seen through the clutine rising from each constricted portion of the branch into centre of body of vase-like portion, which supports the hydrothecæ.

Hydrothecæ in pairs which are distant, opposite, synthecious, tubular, smooth, curved outwards, mouth oblique so that the inner side is lowest, bidentate, teeth acute and unequal in size, largest one external, smallest one internal to the other and lateral.

Gonosomic elements very distinct, *one only* to each hydrocaulis and proximal in position, coming from hydrocaulis close to the most proximal pair of hydrothecæ subsessile, general form ovate, but flattened so that if looked at in a certain position they have a narrower character than in another position. Without a neck or crown, mouth entire but lips tumid.

Allied to *Synthecium elegans.*

Found on very delicate seaweeds after a severe storm on beach at Timaru, also on Ocean Beach ; but rare. (M.C.)

Some are more gelatinous than others, and in a specimen I gathered on the Ocean Beach, Dunedin, 22nd July, 1874, I noticed that the hydrothecæ ensheath the hydrocaulis, so that at different foci they seem more or less separated. In this specimen also the constricted portion of the hydrocaulis is quite different to the one I first discovered on Timaru beach, having a bead-like joint (see figs. 26 and 27) ; and the whole hydrophyton was of a more delicate nature, so that there may be said to be two varieties of *Synthecium gracilis.*

I ought also to add that the hydrothecæ in Timaru specimens are more exsertile than those in Ocean Beach specimens.

The typical characters of the hydrorhiza when magnified are well displayed in fig. 28. Figs. 26—31.

Genus *Thuiaria,* Fleming.

"Hydrosoma variously branched. Hydrothecæ biserial, adnate or imbedded in the substance of the stem and branches."

THUIARIA SUB-ARTICULATA, sp. nov.

T. articulata, Hutton *nec* Johnston.

Hydrophyton strong, erect, about four inches in height ; colour brown. Hydrocaulis thick, pinnately branched, main branches radical or nearly so, pinnæ sub-opposite.

Rachis and branches clothed with a fibrous network, fibres of which spread from hydrorhyza and open out over the object to which the hydro-

phyton is attached, sending branches upwards at intervals and many anchoring threads downwards.

Hydrothecæ sub-opposite and alternate; tubular and curved; smooth, lips dentate; teeth, two small ones internally, which are acute; two indistinct ones laterally, which are depressed.

Gonangia pedicellate, obovate with strong cross ribs arranged in a moniliform manner, a distinct neck, mouth with everted lips.

Allied to *Th. articulata,* Johnst., Brit. Zooph., p. 84, but differs from it in toothed aperture of hydrothecæ and ribbed gonangia. This species is identical with *Thuiaria articulata* of Captain Hutton, which species Captain Hutton himself noted as being doubtful.

Habitat.—Sometimes in long feathery branches springing from a shell, in others short stunted branches from an extensive network of hydrorhiza. Above description was taken from a specimen sent down to Otago Museum by Dr. Fleming, of Oamaru. I have since obtained it in large quantity on Timaru beach, but scanty on southern coast of New Zealand, so far as I have been. Figs. 32—34.

" *Thuiaria zealandica.*

" *T. zealandica,* Gray. Dieffenbach's New Zealand, II., 214.

" Pale brown, erect, branches oppositely pinnate. Hydrothecæ small, exactly opposite, triangular; aperture truncated, with a small central tooth. 'New Zealand (Dr. Sinclair.)'"

Neither Captain Hutton nor I have seen any specimens.

Genus *Antennularia,* Lamarck.

" Hydrophyton variously branched, branches clothed with hair-like verticillate branchlets. Hydrothecæ small, sessile, campanulate, unilateral.

Antennularia antennina, Hutton.

S. antennina, Linn., Syst., 1310.

A. antennina, Johnst., Brit. Zooph., p. 86.

" Hydrophyton strong, erect, sub-pinnately branched."

Branches not jointed as in British specimen, but filiformly wrinkled, and chief hydrocaulis springs from "a sponge-like mass composed of numerous implexed tubular fibres." Branchlets numerous and jointed, bending towards the branch. Hydrothecæ small campanulate with an even rim, with two or three intermediate cellules. Gonangia ?

The above description is chiefly a compound of Captain Hutton's and Dr. Johnston's, both of which I have compared with the specimens; in my specimens the branches are not jointed but distinctly wrinkled as above stated, thus differing from Dr. Johnston's description.

Fig. 36 is after Johnston; fig. 35 is original.

M. Coughtrey del. J.B. lith.

Genus *Plumularia*, Lamarck.

Hydrophyton simple or branched, the branches pinnate, and plumose; hydrothecæ small, sessile and unilateral.

Plumularia pennatula, Hutton.

S. pennatula, Ell. and Sol., Zooph., 56.

P. pennatula, Johnst., Brit. Zooph.

"Hydrophyton simple, or sparingly branched, formed by a single tube, branches alternately closely pinnate, brown or reddish-brown.

"Hydrothecæ approximated, seated in the axil of a long incurved spine, aperture unequally crenated. Gonangia large, subcylindrical, stalked, with numerous transverse strongly denticulated ribs, situated on the inner side of the branches."

Captain Hutton describes the long process in axil of which hydrotheca is placed as a "spine," but Dr. Johnston's description of it as "a long tubular incurved process" is more correct (see fig. 37). The great length of this process is noteworthy. The aperture of each hydrotheca is more dentated than crenated, and the lower two-thirds of hydrocaulis is naked; there is a distinct joint in every branch opposite the base of each hydrotheca. Gonangia I have not seen. "Lyall Bay. (F.W.H.) Common." Fig. 37.

I have not collected any specimens of this species, and am indebted to Captain Hutton for specimens of it.

Plumularia banksii, Gray.

Regarding this species there is some doubt. Dr. Gray's description in Dieffenbach's New Zealand, II., p. 294, is as follows:—

"*Plumularia banksii*, Gray.

"Inhabits Dusky Bay, New Zealand. (Sir Joseph Banks). Stem compound, branched; branchlets simple, opposite, pinnate, unilateral, incurved; cells close, rather crowded, bell-shaped, toothed at the mouth; vesicles—?

"Allied to *P. myriophyllum* (Johnst., Brit. Zooph., 145, t. 29, figs. 4 and 8) but more branched."

Captain Hutton's description, Trans. N. Z. Inst., V., 1872, p. 259, is different to above.

"Hydrophyton irregularly branched, composed of several tubes; branches *alternately* closely pinnate; pinnæ leaning to one side; reddish-brown. Hydrothecæ approximated seated in the axil of a *double incurved spinous process*, aperture with an obtuse tooth on each side. Gonangia—?

"Lyall Bay (F.W.H.) A single specimen only."

It is improbable that both of these descriptions refer to the same species, and it seems to me that it would be preferable to change the name of the

species found and described by Captain Hutton to some other name, and I therefore propose for it the name of *Plumularia huttoni.*

Plumularia huttoni, sp. nov.

Pl. banksii, Hutton, Trans. N. Z. Inst., V., 1872, p. 259.

Hydrophyton irregularly branched, reddish-brown, main stem and branches filiformly wrinkled and composed of several tubes; branches alternately and closely pinnate; pinnæ leaning to one side. Hydrothecæ approximated seated in the axil of two incurved but unequal spines. Apices of both spines not patent. Aperture of hydrothecæ sinuous and wide, with an obtuse tooth on each side. Gonangia—? Lyall Bay. (F.W.H.) A single specimen only, lent to me by Captain Hutton. Fig. 38.

Plumularia simplex, sp. nov.

Hydrophyton short and bushy, scarcely one inch in height; pale brown. Branches radical arising from a tuberous hydrorhiza, simple, undivided, pinnate. Pinnæ distant alternate leaning to one side; jointed between hydrothecæ.

Hydrothecæ distant, in two rows on inner side of pinnæ, alternate, campanulate, lips everted and dentate, teeth three equidistant, short and rounded. No spines or tubular. Gonangia—?

Two specimens only. Ocean Beach after strong storms. (M.C.) Fig. 39.

Plumularia incisa, sp. nov.

Hydrophyton delicate, singly plumed, reddish-brown, short.

Hydrocaulis radical arising from a tuberous hydrorhiza, simple, undivided, pinnæ close, sub-opposite.

Hydrothecæ approximated arising from axis of a short incurved tubular process, which is slightly longer than the hydrotheca.

Hydrotheca has a hollow incurved spinous process with a complete apex arising from the outer side near aperture, aperture incised and lobed, lobes irregularly imbricate. Gonangia—?

From a specimen obtained by Captain Hutton in Lyall Bay, Wellington. Figs. 40 and 41.

Sub-order Campanularida, Johnston.

Hydrosoma plant-like, chitine gelatinous, hydrorhiza filiform and creeping, hydrothecæ thin and campanulate, supported on ringed pedicels, alternate or irregular, gonophores deciduous; produces free medusoids.

Genus *Laomedea,* Lamouroux.

Hydrosoma branched, pedicels short, hydrocaulis with ring joints, hydrothecæ alternate and campanulate, gonophores stalked.

Laomedea geniculuta, L.

L. geniculata, Johnst., *l.c.,* p. 103.

Hydrophyton gelatinously transparent, about one inch high. Hydrocaulis

flexuously zig-zag, simple or dichotomously branched, incrassated below the joints and ringed above them. Arising from a delicate tubular hydrorhiza that runs in parallel rows chiefly on older and dead fronds of larger seaweeds. Hydrothecæ on ringed pedicels, rings vary from four to eight in number, aperture entire.

Gonangia, various forms, generally urceolate, some with pure tubular crown and erect aperture, others with an everted lip, others with no crown at all, and these are campanulate; gonangia pedicellate, pedicels of two to four rings.

Habitat.—Fronds of seaweed. Very widely distributed.

Captain Hutton was the first to discover and determine this species in New Zealand, and incorporated with the above description are some notes he lent me. Figs. 42—44.

Genus *Campanularia*, Lamarck.

Hydrosoma branched or simple, pedicels long. Arising irregularly or in verticils. Gonophores sessile.

Campanularia integra (?), Hutton.

Macgillivray, Ann. and Mag. N. H., IX., 465; Johnst., *l. c.*, p. 109.

"Hydrocaulis a single creeping filiform tube; hydrothecæ on long slender twisted pedicels; campaniform, with an entire rim. Gonangia large, sessile, campanulate, slightly constricted below the rim, which is entire.

"On Fuci, Wellington Harbour."

I have not been able to get a fresh specimen of this species, and although Captain Hutton gave me some dried specimens I prefer giving a description he gave me of it, which had been taken whilst the object was fresh.

Of this I am certain, however, that the species figured in fig. 45 (which is taken from a fresh specimen got at Tairoa Head) is not *Campanularia integra*, Johnston.

I defer my notes on this species until I have had further opportunities of studying it.

CAMPANULARIA BILABIATA, sp. nov.

Hydrophyton creeping and gelatinous. Trophosomic and gonosomic elements distinct, former stalked, latter sub-sessile.

Hydrocaulis 0·5 inch in length. Erect, *simple*, one-celled, contracted at hydrorhiza, only one bead-like joint at proximal end of hydrotheca. Cænosarc tumid at each end of this bead.

Hydrotheca at an oblique angle to stalk, digitaliformly campanulate; lip sinuously bilabiate.

Gonangia almost alternate with nutritive buds. Two forms long and short. General form urceolate, but endoderm has a marked campanulate

form. Lips entire, contracted by a joint where they join hydrorhiza. Spores arranged in several spiral rows around blastostyle.

Habitat.—Fuci, one to three fathoms, Timaru; delicate seaweeds; growing from roots of Laminarians.

This species well illustrates what I have noticed in other species, that there is a sensible difference in size, even in same species, in those I have got on southern beaches as contrasted with those got on eastern beaches, the latter being by far the largest. Figs. 46—49.

Greene, in Manual of Cœlenterata, p. 128, mentions that there is a species of *Cryptolaria* (a Sertularian) found in New Zealand, other members of this genus being found in Madeira.

I have collected a few more species than I have had time to describe, but I hope to contribute on the same subject to next year's Transactions.

Description of Plate XX.

Note.—All objects magnified 50 diameters, except where otherwise specified.

Fig. 1. *Sertularia johnstonii.* Typical specimen. *a* and *b*, different views of the hydrothecæ.

2. Variety of *Sertularia johnstonii*, possessing the oblique joint.

3, 4, and 5. Different forms of gonangiums of *Sert. johnstonii.*

6. Position and form of hydrothecæ on secondary branches of *S. monilifera.*

7. Gonangium of same.

8. *Sertularia simplex.* Type.

9. A variety of *S. simplex.* Shows its relation to *S. polyzonias.*

10. Another var. of *S. simplex.* Shows still better the relations of this species to *S. polyzonias.*

11. Gonangium of *S. simplex.* Type.

12. Part of a ramule of *S. ramulosa*, showing hydrothecæ and gonangium.

13. Habit and general form of *Sertularia ramulosa.* Half nat. size.

14. *Sertularia trispinosa.* Fig. 16 gives form of gonangium.

15. *a*, one of the varieties of *S. trispinosa*; *b*, the second variety of *S. trispinosa*; this shows well its plumularian habit. Half nat. size.

16. Gonangium common to *Sert. trispinosa*, *Sert. bispinosa*, and *Sert. abietinoides.*

17. Portion of hydrocaulis of *S. bispinosa.* Gonangium shows the stunted process mentioned in the text.

18. *Sertularia abietinoides*, a pinna magnified.

19. Profile view of gonangium common to *Sert. trispinosa*, *Sert. bispinosa*, and *Sert. abietinoides.*

Fig. 20. Habit of *Sert. abietinoides,* showing character of branches and pinnæ, and meshwork of hydrorhiza. Half nat. size.

21. Characters of hydrothecæ and hydrocaulis of *S. fusiformis.*
22. Side view of gonangium of *Sert. fusiformis.*
23. Outside view of gonangium of *Sert. fusiformis.*
24. *Synthecium elegans,* after Allman (magnified ?). *a,* ordinary hydrothecæ; *b, b,* gonangia; *c,* hydrothecæ in which hydranth is replaced by the peduncle of gonangium.
25. *Synthecium elegans,* from Stewart Island specimen. It had no gonangia present.
26. *Synthecium gracilis,* from Timaru.
27. *Synthecium gracilis.* Southern variety. Notice its smaller size and the character of joint between hydrothecæ.
28. Typical characters of hydrorhiza in *Synthecium gracilis.* Timaru specimens.
29. Marginal view of gonangium of *Synthecium gracilis.*
30. Full view of gonangium of *Synthecium gracilis.*
31. Habit of *Syn. gracilis,* from Timaru specimen. Half nat. size.
32. Portion of pinna of *Thuiaria sub-articulata.*

33 and 34. Different views of gonangia of *T. sub-articulata.*

35. General habit of *Antennularia antennina. a,* spongy hydrorhiza; *b,* broken portions of shells entangled in hydrorhiza. Half nat. size.
36. One of hairy branchlets of *A. antennina* magnified, after Johnston. *a,* hydrothecæ; *b,* intermediate cellules.
37. *Plumularia pennatula.*
38. *Plumularia huttoni.*
39. *Plumularia simplex. a* alternates with *b, b.*
40. *Plumularia incisa.*
41. Mouth of hydrothecæ in *Pl. incisa.*
42. Part of a single hydrocaulis of *Laomedea geniculata. a,* hydrothecæ; *b* and *c,* different forms of gonangia *in situ.*

43 and 44. Other forms of gonangia in *L. geniculata.*

45. Campanularian allied to *C. integra,* yet undescribed. *a,* cells of frond of seaweed to which it is attached.
46. Upper part of pedicel, and the hydrothecæ of *Campanularia bilabiata.*
47. Long variety of gonangium in *Campanularia bilabiata.*
48. Short " " " " "
49. Habit of *Camp. bilabiata.* Half nat. size.

Art. XLIII.—*Description of a new Crustacean,* Phronima novæ-zealandiæ.

By Ll. Powell, M.D.

Plate XXI.

[*Read before the Philosophical Institute of Canterbury, 15th September,* 1874.]

The little Crustacean I am about to describe belongs to a small family of amphipodous Crustacea which are particularly interesting on account of their habit of what I venture to call eremitism. They are found almost invariably inhabiting the cavities of the tests of certain tunicate mollusks, and what have been described as Beroidæ. One described specimen, however, was found in the stomach of a shark, but whether inhabiting this curious residence from choice or necessity I do not know. Dr. Haast entrusted this specimen to me, Mr. A. E. Ross having found it on the Sumner beach, and presented it to the Museum, and I much regret that I have not the opportunity of showing the *Phronima* alive in its little crystal palace, but the small quantity of sea-water was unfortunately poured away, and we were obliged to transfer it to spirits.

The *Phronima* is about seven-eighths of an inch long when extended; it is as transparent as glass, the eyes alone being coloured red, and was contained in a little cask-shaped body, open at both ends, the openings being slightly contracted, one somewhat smaller than the other, composed of a perfectly transparent semi-cartilaginous substance. It is about three quarters of an inch in length, and half an inch in diameter, irregularly quadrangular, one of the angles slightly winged, the whole being wrinkled transversely. It is the test of a tunicate mollusk, probably one of the Salpidæ. A very similar structure associated with another *Phronima*, found in the Mediterranean, *P. sedentaria*, is figured in the British Museum Catalogue of Amphipoda under the name of *Doliolum papillosum*, Della Chiaje. Our specimen, however, is not papillose and differs in form.

The *Phronima* was doubled up in its cell facing one of the openings, and could not be dislodged without a good deal of pushing; when left at rest he immediately clambered back again.

Dr. Haast tells me that he has frequently found specimens of this little Crustacean on the West Coast, always inhabiting a similar cell.

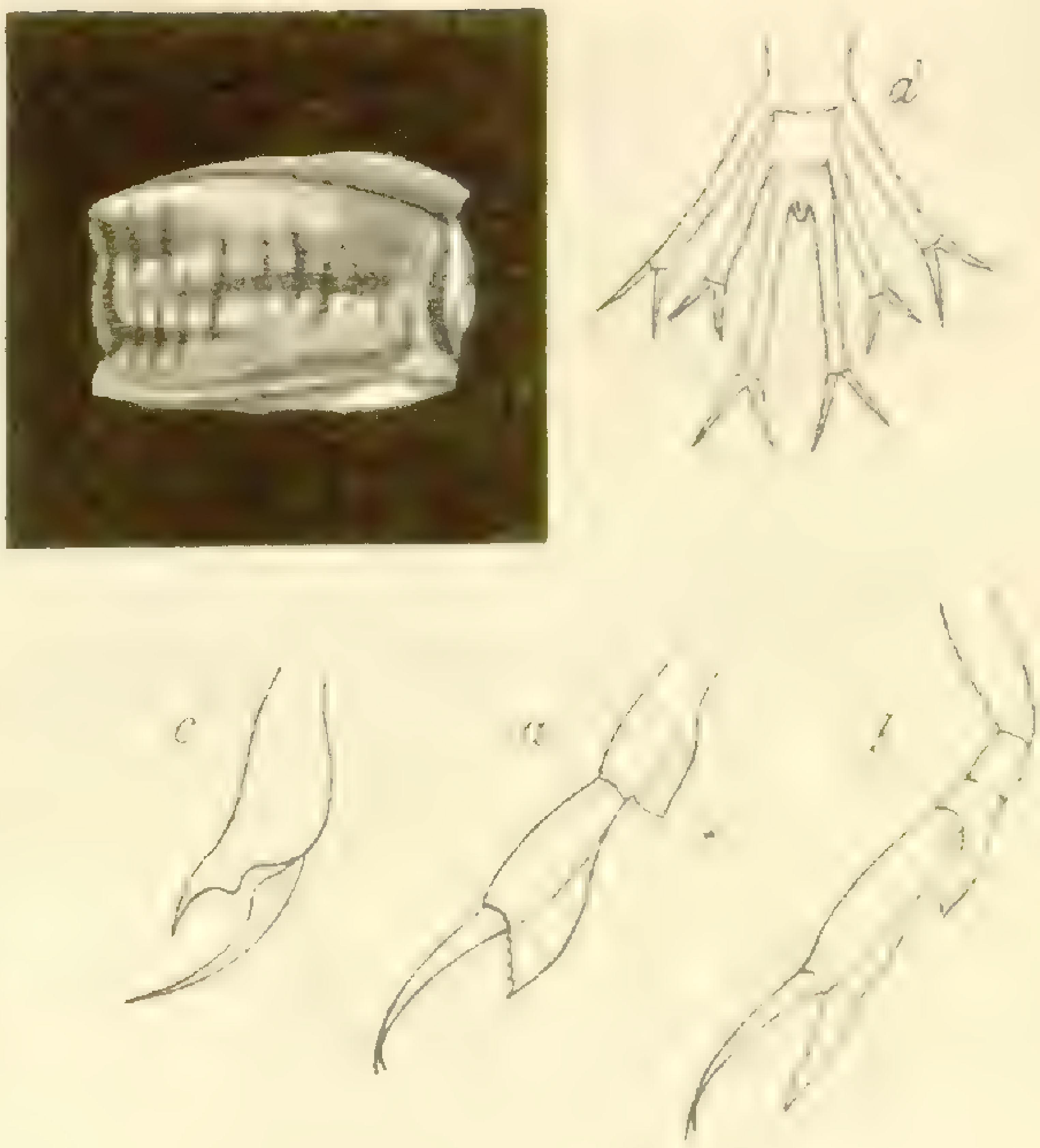
Phronima novæ-zealandiæ, sp. nov.

Cephalon very large, tumid above, tapering to the oral apparatus, finely striated, the striæ being resolvable with a low magnifying power into rows of pellucid dots. Antennæ as long as the breadth of the cephalon at their insertion, the first joint being very short.

First pair of gnathopoda having the meros slightly produced postero-

Fig. 1.

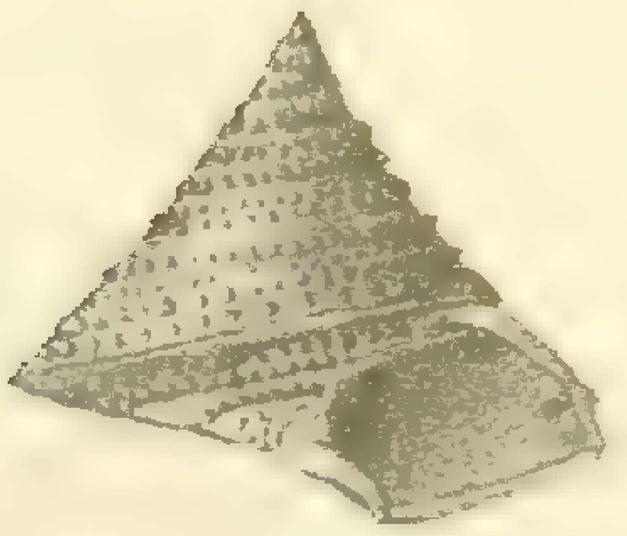
Fig. 2.



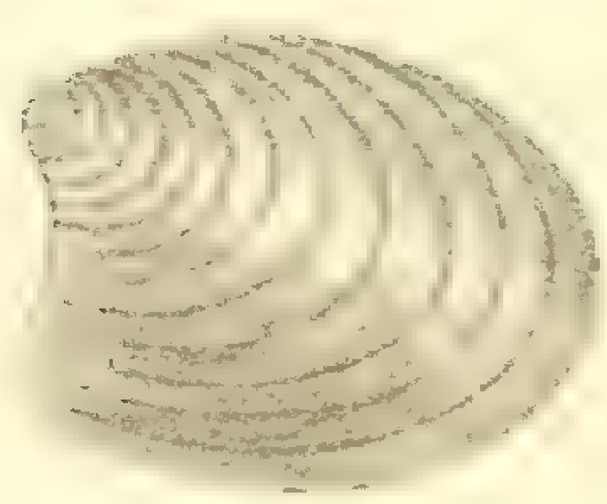
Phronima novæ-zealandiæ, × 32.

[illegible] del.

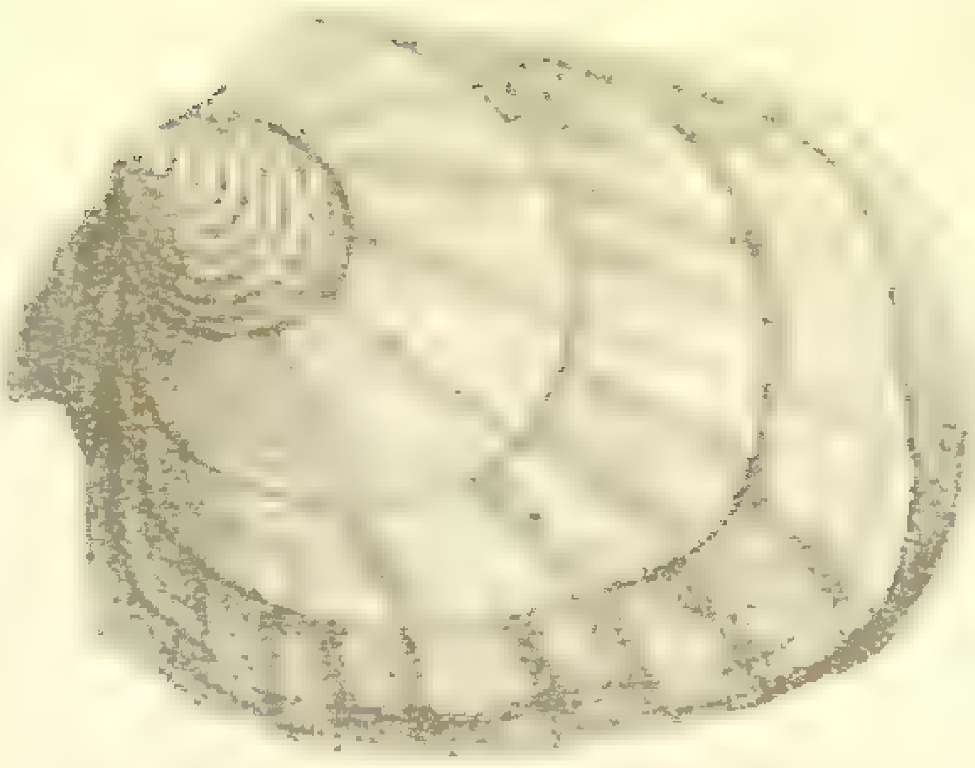
[illegible], Hutton.



[illegible], Hutton.



[illegible], sp. nov.



[illegible], Hutton.

[illegible]

[illegible], sp. nov.

distally, the carpus produced to nearly half the length of the propodos postero-distally, the anterior edge serrated, terminating in a sharp point.

Second pair of gnathopoda have the meros produced postero-distally into a long narrow process, nearly half the length of the carpus; the carpus has a similarly situated long narrow process, more than half the length of the propodos.

Third pair of pereiopoda have the base produced postero-distally into a sharp point not quite at the termination of the basos and springing off at a rather obtuse angle, the ischia produced antero-distally into a small sharp tooth; the carpus antero-distally produced to two-thirds the length of the propodos, provided with a prominent tooth at the centre of its inner margin; propodos long and slender, falcate, and furnished with an obtuse tubercle, corresponding to the proximal aspect of the carpal tooth.

The whole animal perfectly pellucid with the exception of the eyes which have a red colour.

Diagnostic points.—The long sharp process on the mera of the second pair of gnathopoda, the processes on the basa and ischia of the third pair of pereiopoda. Whether these characters are of sufficient importance to raise *P. novæ-zealandiæ* to the dignity of a species I am not sure, but they at all events constitute it a well marked variety, quite as deserving of ranking as a species as *P. custos, P. bornerasis,* and *P. atlantica.*

REFERENCES TO PLATE XXI.

Fig. 1. *Phronima novæ-zealandiæ,* magnified three and a half times.

2. Test of Salpian.

a. 1st gnathopod of *Phronima novæ-zealandiæ.*

b. 2nd gnathopod.

c. Chela of third pereiopod.

d. Extremity of pleon, showing three last pairs of pleopoda and telson.

ART. XLIV.—*On the Disappearance of the larger Kinds of Lizard from North Canterbury.* By the Rev. J. W. STACK.

[*Read before the Philosophical Institute of Canterbury,* 7th May, 1874.]

THE absence of living specimens, coupled with the absence of all traces of recent remains, would render the task of proving that the large lizards existed till quite lately in this part of the country very difficult but for the fact that there are many Maoris still living who have not only seen but handled and

even eaten them. To prevent the knowledge of an interesting zoological fact being lost I have written down the statements of such of the natives whose testimony seemed most worthy of credit. They are persons whose names appear in the earliest records of the colony as leading members of the native community, and therefore from their age may be considered competent to give evidence upon matters of fact which occurred under their observation forty or fifty years ago.

The following is a summary of the statements made by Te Aika, Te Uki, Iwikau, and Te ata o Tu :—

Unu ngarara or ngarara burrows were frequently met with on the plains. They were plentiful in the manuka scrub extending from the banks of the Waimakariri past the present site of Eyreton westwards towards the ranges, and at Waitui, between the Hurunui and Waiau rivers. The ngarara was darker in colour than the ruatara. They varied in size from two to three feet in length, and ten to twenty inches in girth; along the back from the nape of the neck to the tail was a serrated crest. The mouth was full of teeth, some grew large and caused the upper lip to project. These when taken from the jaw were three or four inches long, and half an inch at the base; when split in two and polished they were prized as mat pins.

A ngarara known as Te iha was kept a long time at Kaiapoi. It was fed on small birds and prepared fern-root. It was very gentle and liked being stroked, uttering at the time a guttural sound expressive of pleasure. When it made this noise at any other time it was an indication that it wanted food or water.

Besides the kind frequenting the manuka scrub there was a smaller ngarara, about eighteen inches long, found in the streams. Horomona Iwikau was eeling some time before the fall of Kaiapoi at Orawhata, a stream which rises near Riccarton and falls into the Waimakariri. After having caught a great many eels, which he killed with a billet of wood, he was terrified by the cries of one he was in the act of killing; though very frightened, he continued to strike till the sound ceased. On examination he found it was a ngarara; becoming emboldened he lit a fire, and cooked and ate it. The natives attribute the disappearance of the large ngarara to the introduction of cats and to frequent fires. The Norwegian rat has probably a hand too in the extinction of these reptiles.

While upon the subject of lizards I may add the following anecdote which tends to throw light upon a question that seems likely to be disputed, namely, whether Maoris ate lizards in former times. (*Vide* Major Mair's paper, Trans. N. Z. Inst., Vol. V., Art. XVIII).

Hakopa te Ata o Tu, a well-known Kaiapoi chief, who was taken prisoner by Te Rauparaha and spared on account of his great valour, while in captivity

at Otaki, was invited one day by his master to share the afternoon meal. When seated by the basket containing the food his master asked him whether he would have some fish. Yes, he replied, but where did you obtain it? Ask no questions, was the answer, taste and see how you like it. He did taste and found it very good. When the meal was over his master told him he had eaten the flesh of a lizard, but warned him never to call it anything but fish, otherwise it would be impossible for him to overcome his natural repugnance to it. During his residence at Otaki, Hakopa often joined in ngarara hunts, when as many as forty were caught and eaten. It would appear from his account, and from what other natives say, that the large lizard was formerly eaten, but not as a common article of diet, only by those who had cultivated a taste for what was generally regarded with abhorrence. By rising superior to popular prejudice in this matter individuals obtained a certain notoriety in the tribe, which they turned to their own advantage in other ways.

ART. XLV.—*On the Geodephagous* Coleoptera *of New Zealand.*

By H. W. BATES, F.L.S.

[*From the Ann. and Mag. Nat. Hist., March and April,* 1874.]

IT has been stated that the insect-fauna of New Zealand is extremely poor, and that the Coleoptera at least show great affinity with those of north temperate regions. With regard to the former statement, although some weight ought to be attached to the unanimous complaint of collectors of the general scarcity of insects, it is premature to arrive at a definite conclusion so long as the islands have not been thoroughly worked. At present we know scarcely anything of the productions of the central and western portions of the Northern Island, or of the mountainous districts of the Canterbury Province in the Southern. Although insular and, especially, oceanic faunas are known to be poor, it remains to be seen whether the large area, varied surface, and lofty mountain-ranges of New Zealand have not operated to check the process of extinction without repopulation which has impoverished other insular areas. At present the total number of species of Geodephagous Coleoptera known from the islands is 89; the British Isles have 311, and Japan 244.

The belief that the New Zealand Coleopterous fauna is related to that of the north temperate zone is certainly ill-founded; but it was excusable so long as describers, without attempting to study the characters of the new species before them, referred them recklessly to familiar northern genera, such as (to cite cases from the present group) *Dromius, Cymindis, Calathus, Lebia, Harpalus,* etc., the species so referred having no near affinity whatever to those

genera, but belonging to purely Australian or Antartic forms. Our material, as far as it goes, shows a great specialization of the New Zealand fauna. Thus, out of the total number of thirty-seven New Zealand genera of Geodephaga, no fewer than fourteen are peculiar to the islands; of the remainder, eight are Australian and two are Chilian: seven genera only are common to New Zealand and the north temperate zone; and these are genera of universal distribution. There remain six genera, described as *Argutor*, *Feronia*, etc., which I have not yet seen, and therefore class as doubtful.

Many of the species described or enumerated in the following paper have been communicated by Messrs. Wakefield and Fereday, of Christchurch, and Mr. Lawson of Auckland; and it is at the desire of these gentlemen and other local naturalists, who are labouring to gather together the scattered materials of the New Zealand fauna, that I have undertaken this task.

Coleoptera Geodephaga.

Family Cicindelidæ.

Cicindela tuberculata, Fab. Syst. Entom. p. 225.

Northern and Southern Islands. Auckland; Christchurch.

Cicindela latecincta, White, Voy. Ereb. and Terr., Ins. p.1, t.i. f.1.

Southern Island. Canterbury.

This form is generally considered a variety of *C. tuberculata.* The differences, however, are considerable; for besides the width of the lateral white stripe, which reaches throughout the lateral rim of the elytra, it is a broader insect, with the elytral surface more uniform in colour, and, particularly, the rows of punctures much less marked and with smaller green spots. It must rest with local entomologists to decide, by observing the forms *in situ*, whether they are distinct or not.

Cicindela wakefieldi, n. sp.

C. tuberculatæ similis, at multo minor et angustior; fascia alba mediana elytrorum postice oblique prolongata. Long. 4 lin. M. F.

Very similar to *C. tuberculata* in sculpture, colours, and markings, but certainly distinct. It is always much smaller and narrower; and although the lateral white stripe of the elytra is very similar in form and direction, the median fascia is prolonged as a curved streak some distance down the disk of the elytron. There is also a structural difference in the apex of the elytra, which may better be expressed by a tabular formula :—

Cicindela tuberculata.	*Cicindela wakefieldi.*
Elytrorum apicibus	Elytrorum apicibus
M. conjunctim prolongatis, suturâ longe spinosâ,	M. conjunctim late rotundatis, suturâ breviter spinosâ,
F. conjunctim rotundatis, suturâ acute spinosâ.	F. singulatim abrupte rotundatis (vel ad suturam fortiter conjunctim emarginatis), suturâ breviter spinosâ.

Very local, near Christchurch. Sent in some numbers by C. M. Wakefield, Esq., but first discovered by Mr. Fereday, of Christchurch.

Cicindela douei, Chenu ; Guér. Mag. de Zool. 1840, pl. xlv.

The figure represents an elongate species evidently of the *tuberculata* group, a little shorter than *C. tuberculata* (11 millims.=5 lines). It is distinguished at once by the apical white lunule of the elytra being represented by a subapical spot.

The locality "New Zealand" given to this species rests on the assurance of a dealer, who was told by the surgeon of a whaling-ship that it was taken there. I have seen no specimen of it.

Cicindela parryi, White, Voy. Ereb. and Terror, Ins., p.1, t.i. f.2.

Port Nicholson ; Christchurch.

Cicindela dunedensis, Casteln., Trans. R. Soc. Vict., pt. 1, Vol. VIII., p. 35.

Dunedin.

The author compares it to *C. parryi*, from which it differs by being narrower. It is "light brown, the elytra covered with spots of a green copper colour." In this respect it differs much from *C. wakefieldi.*

Cicindela feredayi, Bates, Entom. Monthly Mag., Vol. IV., p. 53, 1867.

Mr. Wakefield has recently met with this species in numbers on the sandy bed of the Rakaia near Christchurch. It is distinct from all the members of the *tuberculata* group in its finely granulated elytra without traces of green foveoles.

Family **Carabidæ.**

Section A. *Mesothoracic epimera reaching the middle coxæ.*

Subfamily MIGADOPINÆ.

Amarotypus edwardsii, Bates, Entom. Monthly Mag., Vol. IX., p. 51, 1872.

I have only seen of this curious insect the specimens sent by Mr. H. Edwards, who took it in New Zealand.*

Subfamily SCARITINÆ.

Clivina rugithorax, Putzeys, Stett. Zeit. 1866, p. 37.

A large species (nearly 5 lines), closely allied to a common Australian species, *C. australasiæ*, Boh. I have not yet seen it.

Section B.—*Mesothoracic epimera not reaching the middle coxæ.*

Subfamily BROSCINÆ.

Mecodema sculpturatum, Blanchard, Voy. au Pôle Sud, Zool., Vol. IV., p. 34, t. ii. f. 14.

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* *Heterodactylus nebrioides*, Guér. (*Pristancylus castaneus*, Blanch.), from the Auckland Islands, is another member of this very interesting antarctic group of Carabidæ. *Pristancylus brevis*, Blanch., from the same locality, is doubtful.

Mecodema howittii, Casteln. Trans. R. Soc. Victoria, pt. ii. Vol. VIII., p. 159 (=*rectolineatum*, Putz. Stett. Zeit. 1868, p. 317).

Mecodema rectolineatum, Casteln. *l. c.* p. 160; Putz. Annali del Mus. Civ. di Genova, Vol. IV. p. 4.

Mecodema impressum, Casteln. *l. c.* p. 161: Putz. *l. c.* p. 4.

Mecodema lucidum, Casteln. *l. c.* p. 160; Putz. *l. c.* p. 5.
"Dunedin."

Mecodema crenicolle, Casteln. *l. c.* p. 160; Putz. *l. c.* p. 6.
"Auckland."

Mecodema simplex, Casteln. *l. c.* p. 160; Putz. *l. c.* p. 7.
"Auckland."

Mecodema alternans, Casteln. *l. c.* p. 161.

Mecodema crenaticolle, Redtenbacher, Reise d. Novara, Coleopt. p. 11.

I have not yet seen any species of *Mecodema* from the neighbourhood of Christchurch.

Metaglymma tibiale.
Maoria tibialis, Casteln. *l. c.* p. 163.
"Molyneux River; in the mountains."

Metaglymma monilifer, Bates, Entom. Monthly Mag., Vol. IV., p. 79, 1867.
Near Christchurch. Discovered by Mr. Fereday.

Metaglymma punctatum, Putz. *l. c.* p. 8.
Maoria punctata, Casteln. *l. c.* p. 164.
"Dunedin; in the mountains."

Metaglymma morio, Putz. *l. c.* p. 9.
Maoria morio, Casteln. *l. c.* p. 164.
Otago.

Metaglymma elongatum, Putz. *l. c.* p. 9.
Mecodema elongatum, Casteln. *l. c.* p. 162.

Metaglymma aberrans, Putz. Stett. Zeit. 1868, p. 320.

Metaglymma clivinoïdes.
Maoria clivinoïdes, Casteln. *l. c.* p. 164.
"Wellington."

Metaglymma dyschirioïdes.
Maoria dyschirioïdes, Casteln. *l. c.* p. 164.
"Crooked River."

Oregus æreus.
Promecoderus æreus White, Voy. Ereb. and Terr., Ins. p.5, t.i. f.8.
Oregus æreus, Putz. Stett. Zeit. 1868, p. 327.
Port Nicholson (White).

Oregus inæqualis.

Mecodema inæqualis, Casteln. *l. c.* p. 162.

"Dunedin."

Brullea antarctica, Casteln. *l. c.* p. 166.

"Auckland."

Obs. Percosoma carenoïdes (*Broscus*) White, Voy. Ereb. and Terr., p. 4 (Tasmania), and *Promecoderus lottini*, Brullé, Hist. Nat. Ins., IV., p. 450 (Swan River), have been erroneously given as New Zealand insects.

Subfamily LICININÆ.

Rembus zeelandicus, Redtenb. Reise Novara, Coleop., p.10, t.i. f.5.

"Auckland."

A large species (9½ lines), of which I have seen no specimens from New Zealand. The description and figure agree pretty well with a Chinese species, and there may be an error in the locality.

Dicrochile subopaca, n. sp.

D. oblongo-ovata, subdepressa, nigra, palpis et tarsis rufo-piceis; elytris alutaceis, subopacis; capite parvo; thorace quadrato, postice modice angustato. Long. 4¼—5 lin.

Shorter in form than the common Australian *D. goryi*, and the elytra more ovate; distinguished also by the alutaceous and subopaque surface of the elytra. The head is relatively small, as in *D. goryi*. The thorax is quadrate, moderately narrowed behind, with explanated and reflexed margins; the hind angles obtuse and rounded at the tip, the middle of the base broadly sinuated. The elytra are elliptical-ovate, obliquely and strongly sinuate near the tip, with the suture produced; the lateral margins are somewhat explanated and reflexed, the striæ sharply impressed, the interstices scarcely convex.

Apparently abundant near Christchurch.

Dicrochile aterrima, n. sp.

D. oblonga, nigra, nitida; capite majore; thorace breviore, transverso, quadrato, postice paulo angustato, angulis posticis obtusis, apice rotundatis, margine vix reflexo; elytris oblongis, nitidis, fortiter punctulato-striatis, interstitiis alternis magis elevatis. Long. 5 lin.

Same size as *D. subopaca*, but distinguished at once by its deeper black colour and shining surface, by its larger head (owing chiefly to the much more prominent eyes), and much shorter, more transverse thorax. The palpi and tarsi are also shining black. The elytra are much less sinuate truncate, and the sutural apex less produced; the striæ are punctulate, and the interstices more convex, especially the third, fifth, and seventh.

Taken by Mr. C. M. Wakefield in some numbers at Lake Coleridge, under stones in a dry lagoon.

Dicrochile ovicollis, Motschulsky, Bull. Mosc. 1864, IV., p. 316.

By its elytra "paulo opacis," this may possibly be our *D. subopaco*; but the description of the thorax cannot possibly be intended for that species ("capite fere duplo latiore, ovali"). There is not the faintest approach to the oval form in the thorax of *D. subopaca.*

Obs. Dicrochile fabrei and *D. anchomenoïdes*, cited by authors as described by Guérin (Ann. Soc. Ent. Fr. 1846, Bull. p. 103), must be erased from the list of this genus, as the species are merely named in the place quoted, not described.

Subfamily ANCHOMENINÆ.

Calathus zeelandicus, Redtenb. Reise Novara, Col. p. 17.

Auckland.

It is doubtful if this belongs really to the genus *Calathus*. *C. rubromarginatus*, Blanch., from the Auckland Islands, is decidedly not a *Calathus*, having, according to Chaudoir, four joints of the male anterior tarsi dilated and brush-like beneath.

Platynus deplanatus.

Anchomenus deplanatus, White, Voy. Ereb. and Terr., p. 3, 1846.

A. atratus, Blanch., Voy. Pôle Sud. Zool. p. 21, t. 1. f. 15, 1853.

Blanchard's description is so vague that it is difficult to determine to which of the New Zealand species of the same size (12 to 14 millims.) it applies. Judging from the figure and the expressions "ater, obscurus" and "Elytres obscures, planes," I refer to it a slender, subopaque species existing in some of the London collections, and remarkable for the very sharp furrows and ridges of all the tarsi, and for the uneven slightly rugose thorax, which is subcordate in form, but with produced and rather acute hind angles. The head and eyes are very similar in form to those of *P. scrobiculatus* of Europe. White's description of *A. deplanatus* agrees pretty well with the same insect, and I have little hesitation in adopting the name, although I have not seen his type.

Platynus colensonis.

Anchomenus colensonis, White, *l. c.*, p. 3.

The type in the British Museum is a slender insect, with very elongate thorax, sinuate-angustate behind, and with produced hind angles; the antennæ, palpi, and legs testaceous yellow.

The size is $5\frac{3}{4}$ lines; but I refer to the same species two specimens collected by Mr. Henry Edwards, $4\frac{3}{4}$ and 5 lines in length respectively.

Platynus edwardsii, n. sp.

P. elongatus, modice convexus, niger nitidus, palpis, antennis (articulis 1.—3. exceptis) et tarsis rufo-piceis; capite ovato, pone oculos subconstricto, supra lævi; thorace angusto, quadrato-cordato, post medium fortiter sinuato, angulis posticis productis, acutis; elytris elongato-ovatis, apice fortiter

sinuatis, convexis, profunde subpunctulato-striatis, interstitio tertio tripunctato. Long 5—5½ lin. M. F.

Allied to *P. colensonis*, especially in the form of the thorax, with produced acute hind angles, but legs constantly pitchy black; palpi and antennæ dull pitchy red, with the greater part of the three basal joints of the latter black. The thorax, as in *P. deplanatus* and *P. colensonis*, has a deep central groove, and on each side a curved, shallow, impressed line proceeding from the basal fovea and nearly reaching the anterior angles. The lateral explanated margin is narrow and reflexed. All the tarsi (except the dilated joints of the male) are sharply ridged and grooved, as in *P. deplanatus*.

Anchomenus elevatus, White, *l. c.* p. 3.

A large, shining black species (6½ lines), with large ovate thorax, much larger in proportion to the elytra than in any other described species. The hind angles of the thorax are very obtuse, almost rounded; and the lateral margins are widely explanated and strongly reflexed, of the same width from the anterior to the posterior angle. The elytra are ovate, rather rounded at the shoulders, and strongly sinuate near the apex. The tarsi are grooved only on the sides.

Auckland. Sent in some numbers by Mr. Lawson.

Anchomenus feredayi, n. sp.

A. oblongus, subgracilis, nigro-æneus nitidus, thoracis margine laterali, elytrorum margine deflexo, tibiis tarsisque obscure piceo-rufis; thorace transversim quadrato, angulis posticis distinctis sed obtusis; elytris striatis, interstitiis planis, tertio tripunctato. Long. 3½ lin. M. F.

A small "*Agonum*," having much resemblance to the British *A. micans*, but distinguished, among other characters, by the shorter thorax, scarcely more narrowed behind than in front, with distinct hind angles and pitchy and explanated lateral margins; the anterior angles are rather rounded, not prominent as in *A. tristis*, Dej. The eyes are much more prominent than in *A. micans*, and the palpi shorter and more robust. The frontal foveolæ are deep and well-defined. The elytra are very obliquely and rather strongly sinuate at the apex, with the suture strongly produced; the striæ are sharp and fine, equally impressed from base to apex, and finely punctulate or crenulated; the interstices quite plane, with three large punctures on the third; the deflexed margins and extreme edge of the lateral rims rufo-piceous. The antennæ are robust from the fourth joint, black, with rufous bases to the joints. The palpi and femora shining black; the trochanters reddish testaceous; the tibiæ and tarsi pitchy red. The tarsi are finely grooved on the sides only.

Christchurch. Sent first by Mr. Fereday, and afterwards by Mr. C. M. Wakefield.

Anchomenus lawsoni, n. sp.

A. oblongus, gracilis, nigro-piceus æneo-tinctus, nitidus ; partibus oris, antennis, pedibus (femoribus exceptis), thoracis elytrorumque marginibus lateralibus piceo-rufis ; capite convexo ; thorace paulo transverso, subquadrato, lateribus rotundatis, postice plus quam antice angustato, angulis posticis obtusis sed distinctis ; elytris fortiter striatis, interstitiis subconvexis, tertio tripunctato. Long. 4 lin. M. F.

Longer and proportionally narrower than *A. feredayi*. Thorax conspicuously longer, the posterior narrowing more gradual, and slightly incurved before the hind angle ; striæ of the elytra deeper, and interstices more convex. The antennæ, parts of the mouth, and legs also differ in being wholly dull rufous, except the femora, which are blackish. The anterior angles of the thorax are not at all advanced and are rounded off.

Auckland. Collected by Mr Lawson.

Anchomenus submetallicus.

Colpodes submetallicus, White, *l. c.* p. 2.

According to the type in the British Museum, this is a species closely allied to the common Australian *A. marginellus*, Erichson ; it differs in being less shining, and in the much shorter thorax, the sides of which narrow much more abruptly to the front angles. It is common and generally distributed in New Zealand ; and I have compared a long series with an equal number of the Australian species.

The species has none of the distinguishing characters of *Colpodes* ; the fourth joint of the tarsi, however, is rather more distinctly triangular and emarginate than is usual in *Anchomenus*. It is closely allied to our *A. feredayi*, but is much larger, more brassy, and with clearer yellow margins to the thorax and elytra, besides having yellow legs.

Tropopterus sulcicollis, n. sp.

T. ellipticus, niger, nitidus ; antennis, palpis et pedibus piceo-rufis ; capite spatio inter sulcos laterales haud carinato ; thorace quadrato, vix transverso, medio rotundato, antice plus quam postice angustato, angulis posticis productis rectis, basi utrinque fovea sulciformi ; elytris convexis, striato-punctatis. Long. 3¼ lin. F.

Resembles the genus *Oöpterus*, but distinguished by the pubescence of the antennæ not beginning before the fourth joint, and by the labial palpi having their terminal joint obtuse-ovate, instead of acuminate. Agrees in all essential points with the Chilian genus *Tropopterus* ; allied to *Colpodes*, in which the forehead has on each side two grooves with a carinate interval between them. The eighth and ninth striæ of the elytra are sunk in a broad groove near the apex ; and the seventh at that part is bordered by a sharp carina. The sixth and seventh striæ are nearly obsolete.

One example, female, sent by Mr. Fereday from Christchurch.

Tropopterus seriatoporus, n. sp.

T. ovatus, elytris gibbosis; castaneo-rufus, nitidus; thorace basi grosse punctato; elytris grosse seriatim punctatis. Long. 2⅓ lin. F.

The labial palpi are obtuse; the maxillaries taper to a point almost as in *Oöpterus.* The posterior narrowing of the thorax is strongly sinuated and the hind angles produced; the whole base is very coarsely punctured; the dorsal line and long basal foveæ are deeply impressed. The sutural rows of punctures are impressed in striæ, the rest are superficial; the form of the lateral striæ is as in *T. sulcicollis.*

Mr. H. Edwards; one example.

Cyclothorax insularis.

Olisthopus insularis, Motschulsky, Bull. Mosc. 1864, iv. p. 325.
Drimostoma striatopunctata, Casteln. *l. c.* p. 199 (?)

Differs scarcely from the common Australian *Anchomenus ambiguus*, Erichs. (*Cyclothorax* id., W. M'Leay), the only difference observable being its more æneous colouring.

Auckland and Canterbury.

Drimostoma antarctica, Casteln. *l. c.* p. 199.

M. de Chaudoir suspects this to be an *Abacetus.* I have seen at present no species of either genus from New Zealand.

Subfamily PTEROSTICHINÆ.

Prosopogmus impressifrons, Chaudoir, Bull. Mosc. 1865, p. 28 (separata).

A large species, about 8 lines long, which I have not seen. It is similar in form to *Pt.* (*Trichosternus*) *australasiæ*, but much flatter and of a brilliant brassy coppery hue, with flattened tarsi, having their upper surface finely reticulated.

Trichosternus antarcticus, Chaudoir, Bull. Mosc. 1865, iii., p. 73.
Megadromus viridilimbatus, Motsch. Bull. Mosc. 1865, iv., p. 251.

This fine insect was sent home in some numbers, from Christchurch, by Mr. Fereday. The colour is not always cupreous, but some specimens are black, with the green margins occasionally scarcely perceptible. It may always be distinguished from the obscure-coloured *T. rectangulus* by its larger and broader shape, more protuberant cheeks behind the eyes, and by the thorax being more dilated in front.

Trichosternus rectangulus, Chaud. Bull. Mosc. 1865, iii., p. 74.

Christchurch. Sent both by Mr. Fereday and Mr. Wakefield.

Trichosternus capito, White, *l. c.* p. 4.

Closely allied to *T. rectangulus*; but I have seen no specimens from Christchurch exactly resembling White's types in the British Museum.

Trichosternus guerinii, Chaud. Bull. Mosc. 1865, iii., p. 75.

Platysma australasiæ, Guér. Rev. Zool. 1841, p. 121.

Northern Island ?

Trichosternus planiusculus, White, *l. c.* p.3, t.1. f.7.

Northern Island.

Holcaspis angustula, Chaud. Bull. Mosc. 1865, iii., p. 99.

Omaseus elongatus, Blanch. Voy. Pôle Sud, Zool. iv., p.28, t.2. f.4 (specific name preoccupied).

Christchurch. One example sent by Mr. Fereday. Found also at Akaroa.

Holcaspis sylvatica, Chaud. *l. c.* p. 100.

Omaseus sylvaticus, Blanch. *l. c.* p.29, t.2. f.5.

Akaroa. I have three examples from Mr. Henry Edwards, but do not know their exact locality.

Holcaspis subænea.

Platysma subænea, Guérin, Rev. Zool. 1841, p. 122.

Feronia (*Pterostichus*) *vagepunctata*, White, *l. c.* p.4.

Port Nicholson ; also Christchurch.

I obtained an example from M. Doué's collection named *Platysma subænea*, which is evidently authentic, agreeing with the author's description and the types of *vagepunctata* of White.

Holcaspis œdicnema, n. sp.

H. subæneæ proxime affinis, sed maris femoribus posticis subtus medio valde dilatatis et dentatis. Subæneo-nigra, nitida ; thorace magno, quadrato, postice perparum angustato, ante basin vix sinuato, angulis posticis paulo productis ; elytris brevibus profunde striatis, striis punctatis et passim (præcipue postice) subinterruptis. Long. 8 lin. M.

Much resembling *H. subænea* ; but the elytra are much shorter and the thorax rather longer than in that species. The thorax is very nearly as long as broad, and is somewhat regularly and slightly rounded on the sides, the greatest width being in the middle ; behind it is very much less sinuate, and the hind angles are less produced than in *subænea* ; the basal fovea also is larger, and offers on its outer slope a distinct second smaller fovea ; but some trace of this is visible in well-developed examples of *subænea*. The hind legs are remarkably short, and the femora are widely dilated beneath, forming a tooth, between which and the base is lodged the elongated trochanter.

One example ; in my own collection. Exact locality unknown.

Holcaspis elongella, White, *l. c.* p. 4.

Christchurch. Several examples from Mr. Fereday.

Holcaspis ovatella, Chaud. Bull. Mosc. 1865, iii., p. 103.

Distinguished by its three punctures on the third interstice of the elytra ; otherwise similar to *H. elongella*.

The precise locality of this distinct species (9 lines long) is not known. I have one example obtained from a New Zealand collection, probably from the Southern Island.

The genus *Holcaspis* resembles in general form the parallel species of *Pterostichus*, having, like them, very short metathoracic episterna and the marginal stria of the elytra duplicated towards the apex. It is distinguished by the base of the scutellum being scored by a number of short fine lines; this character, however, is seen in some European species of the *Feronia* group—*e. g. Haptoderus abaxoides*, Dej., *Tapinopterus cephalotes*, Gaut., and others.

Haptoderus maorinus, **n. sp.**

H. oblongus, nigro-piceus, M. nitidus, F. elytris sericeo-subopacis; palpis pedibus, antennisque plus minusve piceo-rufis; capite foveis frontalibus vix impressis; thorace quadrato, lateribus antice paulo rotundatis, post medium leviter sinuato-angustatis, angulis posticis paulo productis rectis, fovea basali utrinque unica profunda, toto impunctato; elytris postice paulo angustatis, apice haud sinuatis, striis profundis simplicibus, interstitio tertio bipunctato. Long. $3\frac{1}{2}$—$3\frac{3}{4}$ lin. M. F.

Christchurch (*C. M. Wakefield, Esq*).

Similar in form to *Holcaspis sylvatica*, but wanting the essential character of the group—the striated base of the scutellum. In all essential characters it agrees with the European *Haptoderi*. The palpi have the terminal joints narrowed to the tip and very briefly (the maxillaries in the male not at all) truncated. The head is rather small, and shows scarcely any trace of the usual frontal foveæ; the thorax has on each side of the base a single deep, almost sulciform, fovea, and its whole surface is impunctate. The elytra have a well-developed scutellar striole between the suture and the first stria; the interstices are plain in the subopaque female and a little more convex in the shining male, but in both sexes they become narrow and convex at the apex, and the first stria is continued round the apex to the marginal stria.

Argutor erythropus, Blanch., as far as the very insufficient description goes, agrees with this species; but no mention is made of the two punctures on the third interstice.

Argutor pantomelas, Blanch. Voy. au Pôle Sud, Zool. iv., p.27, t.ii. f.6.

8—9 millims. Rather broad, black; elytra nearly plane; palpi clear red; thorax with two lineiform foveæ on each side.

The description almost applies to the *O.* (*Holcaspis*) *sylvaticus* of the same author; and the species probably belongs to *Holcaspis*.

Argutor erythropus, Blanch. *l. c.* p. 27, t.ii. f.7.

Probably a *Haptoderus*.

Argutor piceus, Blanch. *l. c.* p. 28, t. ii. f. 8.

The head is described as having two large rugose foveæ, and the elytra as ovate.

Feronia (Platysma) vigil, White, *l. c.* p. 3.

Nothing can be made of the superficial description given.

Feronia (Platysma) politissima, White, *l. c.* p. 4.

Port Nicholson.

The same remark as above applies to this species.

Molopsida polita, White, *l. c.* p. 6.

Waikouaiti.

I have not succeeded in finding the type of this insufficiently described genus and species in the British Museum.

Alogus monachicus, Motsch. Bull. Mosc. 1865, iv., p. 245.

7½ lines. Similar to *Omaseus* in form, but broader and without scutellar striole. Metathoracic episterna a little longer than broad. Thorax nearly twice the width of the head, transverse, cordate, base on each side bisulcate; sides arcuated; hind angles prominent, acute. Elytra with one puncture on the third interstice.

I have seen no species agreeing with Motschulsky's description.

Cerabilia maori, Castelnau, *l. c.* p. 202.

Dunedin.

Belongs to the *Feronia* group, according to the author; but the mentum is described as without tooth, and the palpi as pointed. The species is 4½ lines long, brown, and elytra feebly striated.

Rhabdotus reflexus, Chaud. Bull. Mosc. 1865, iii. p. 94.

Notwithstanding the almost invariable accuracy of M. de Chaudoir, I suspect an error in the locality he gives to this species. The specimens I have seen are all from Tasmania.

Subfamily Anisodactylinæ.

Triplosarus, nov. gen.

Corpus breviter oblongum, subdepressum. *Caput* pone oculos haud angustatum. *Mandibulæ* edentatæ, basi latæ, apice angustatæ et curvatæ. *Labrum* medio leviter emarginatum, angulis rotundatis. *Mentum* medio dente forti, acuto; lobis extus valde rotundatis, apice intus acutis; epilobiis haud conspicuis. *Ligula* oblonga, apice libera, recte truncata; paraglossis apice æque truncatis, longitudine et latitudine ligulæ æqualibus. *Thorax* transversim quadratus. *Elytra* apice obtuse rotundata, paulo sinuata; striola scutellaris longa, inter strias primam et secundam posita. *Tibiæ* setosæ; anticæ extus 5-spinosæ.

M. *Tarsi* quatuor anteriores articulis secundo ad quartum dilatatis, pedum anteriorum brevissimi, intermediorum longiores cordati; articulo quarto nullomodo lobato; palmis ut in *Anisodactylo* dense breviter setosis, planis; articulo primo triangulari, subtus nudo.

This genus differs from the other *Anisodactylinæ* in the form of its head and mandibles, which resemble those of *Phorticosomus, Cratacanthus,* etc., but the eyes are rather prominent; the suture separating the epistome from the forehead is very sharply impressed, and has a short deep frontal foveole near each end. The paraglossæ are lateral, and not placed behind the ligula, as in other genera of the group.

Triplosarus fulvescens, n. sp.

T. ochraceo-fulvus, subnitidus, capite thoraceque interdum æneo tinctus; thorace antice rotundato, postice modice angustato, angulis posticis obtusis, basi utrinque fovea lata, indistincte punctulata; elytris in utroque sexu sericeis; interstitiis planis, tertio postice unipunctato. Long. 4—4½ lin. M. F.

Harpalus novæ-zealandiæ, Casteln. Trans. R. Soc. Vict. pt. ii. vol viii., p. 194?

Castelnau's description applies to the species as far as it goes, except the size (5 lines). My specimens came from Mr. Henry Edwards (from Auckland ?) and Mr. Fereday of Christchurch.

Lecanomerus latimanus, n. sp.

L. ovatus, piceo-fuscus, modice nitidus; partibus oris, antennis, pedibus, elytrorumque marginibus (postice dilatatis) fulvo-testaceis; thorace transversim quadrato, vix postice angustato, angulis posticis rotundatis, supra basi lævi haud foveato; elytris ovatis, convexis.

M. Tarsi quatuor anteriores articulis secundo et tertio magnis, maxime dilatatis; secundo semicirculari; tertio paulo breviore, haud angustiore; primo breviter triangulari; quarto brevissimo, lato, quam tertio paulo angustiore, nullomodo lobato. Long. 2½ lin. M.

The form of this curious insect is that of an *Oöpterus*, the elytra being ovate (much broader than the thorax) and convex; but the broad patelliform anterior and middle tarsi of the male, with their even, smooth brush-soles, show that it belongs to the Australian genus *Lecanomerus*, Chaud. It agrees in all other generic characters with *L. insidiosus*; but the second tarsal joint is shorter and more semicircular, and the fourth is much broader. The elytra in the unique specimen are dark pitchy brown with fulvous lateral margins, not very well defined, but widening much at the apex; there is no puncture on the third interstice, and there is a short scutellar striole between the first and second striæ. The margins of the ventral segments are more or less fulvous.

One example, from New Zealand. Obtained from the late Rev. Hamlet Clark's collection.

Hypharpax antarcticus.

Harpalus antarcticus, Castelnau, *l. c.*, p. 193.

Christchurch (*Mr. Fereday*).

Scarcely belongs to *Hypharpax*, the hind tibia of the male not being arcuated; in facies and in the long fine bristles on the inner side of the tibia, with a row of shorter spines on the outer side, it resembles that genus. Four joints of the four anterior tarsi of the male are dilated, and smooth, brush-like, beneath.

Hypharpax australasiæ.

Harpalus australasiæ, Dej. Sp. Gén. iv., p. 386.

Hypharpax australis.

Harpalus australis, Dej. *l.* c., p. 385.

Both these species are found in New Zealand, according to Redtenbacher.

Although only the female in each case was described by Dejean, I think they belong to the genus *Hypharpax*.

Subfamily HARPALINÆ.

EUTHENARUS, nov. gen.

Gen. *Tachycello* similis. *Palpi* robusti, glabri; articulo terminali fusiformi, versus apicem attenuato, apice leviter truncato. *Antennæ* robustæ; articulo undecimo multo longiore, crasso. *Mentum* parvum, emarginatione semicirculari, dente mediano prominulo acuto. *Ligula* cornea, oblonga, apice libera bisetosa; paraglossis ipsa duplo latioribus et multo longioribus, apice late rotundatis.

M. *Tarsi* quatuor anteriores articulis quatuor valde dilatatis: primo triangulari; secundo ad quartum brevissimis et latissimis; quarto bilobo; omnibus laciniis argenteis longissimis vestitis.

The insects on which this distinct new genus is founded resemble the *Bradycelli* and small *Stenolophi* of the northern hemisphere, but are widely different in the clothing of the four dilated palms of the male. This is unlike either the squamæ arranged in pairs of the true Harpalidæ, or the even brush of short vertical hairs of the *Anisodactylinæ*, but consists of a few very long linear hair-scales set obliquely on the broad palms and forming a broad fringe to the feet. The paraglossæ also differ from those of the *Harpali* in being very broad, not tapering to the apex, but broadly rounded. The frontal foveæ of the head form short striæ curving to the inner margin of the eye. The thorax is quadrate. The elytra are obtuse at the apex, with a strong sinuation; the scutellar striole is rudimentary between the first and second striæ; the third interstice has one puncture. The males have a hairy fovea in the middle of the first ventral segment, like the *Tachycelli*.

Euthenarus brevicollis, n. sp.

E. oblongus, fusco-æneus; elytris subcupreis; antennis basi, palpis apice, genibusque piceo-rufis; thorace postice paululum angustato, angulis posticis obtusis fere rotundatis, fovea utrinque lata sparsim punctulata; elytris acute striatis, interstitiis planis. Long. $2\frac{3}{4}$ lin. **M. F.**

Lake Coleridge; under stones in dry lagoon (*C. M. Wakefield, Esq.*).

Immature specimens have testaceous-yellow legs and pale under surface of body; but the dark brassy colour of the head and thorax and cupreous elytra remain in all the numerous individuals sent. The hind angles of the thorax are distinct in some examples and perfectly rounded off in others; the basal foveæ also vary in the amount of punctuation, which is always rather coarse.

Euthenarus puncticollis, n. sp.

E. oblongus, fusco-piceus æneo tinctus vel cupreo-æneus; antennis basi, palpis basi et apice, pedibus (femoribus interdum exceptis) rufo-piceis; thorace longiore, postice subsinuatim paulo angustato, angulis posticis fere rectis, fovea basali grosse punctata; elytris apice fortiter sinuatis, subtruncatis. Long. $2\frac{3}{4}$ lin. **M. F.**

Apparently distinct from *E. brevicollis*, although similar in size and colouration. It is decidedly slenderer, with longer thorax, the posterior narrowing of which is slightly incurved and the hind angles more distinct. The general colour is less metallic, and the side rims of the thorax are pale, which is sometimes the case with *E. brevicollis*. A better distinction is the more transverse and stronger sinuation of the apex of the elytra, the edges external to the sinuation being more flattened out; they are finely and sharply striated in the same manner.

Auckland. Several examples from Mr. Lawson and Mr. H. Edwards.

Subfamily TRECHINÆ.

Oöpterus rotundicollis, White, Voy. Ereb. and Terr., Ins. p. 6.

Bay of Islands.

Oöpterus lævicollis, Bates, Entom. Monthly Mag. vol. viii. 1871, p. 14.

New Zealand; precise locality unknown.

Two other species of this genus are described from the Falkland Islands.

It is very easy to confound this genus with *Tropopterus*, belonging to a quite different subfamily, the resemblance in general form between the two being very great.

Subfamily BEMBIDIINÆ.

Tachys antarcticus, n. sp.

T. oblongo-ovatus, convexus, testaceo-rufus nitidus, palpis pedibusque flavo-testaceis; capite foveis frontalibus, magnis, profundis, interspatio elongato,

convexo: thorace subcordato, lateribus antice valde rotundatis, post medium sinuatim angustato, angulis posticis productis acutis; supra antice convexo, postice transversim depresso, utrinque foveolato, lævi: elytris ovatis, humeris rotundatis utrinque striis 3 prope suturam, fortiter impressis, subpunctatis; interstitio tertio bipunctato. Long. $\frac{3}{4}$ lin.

In form intermediate between *T. hæmorrhoidalis*, Dj., and *T. globulus*, Dj. As convex as the latter, but much more slender, the thorax especially being narrower (much narrower than the elytra), more cordiform, and the elytra more ovate and rounded at the shoulders. The antennæ are wanting in both my specimens.

Auckland? (*H. Edwards, Esq.*).

Bembidium (*Peryphus*) *maorinum*, Bates, Ent. Monthly Mag. iv. p. 56 (1867).
Christchurch (*Mr. Fereday*).

Bembidium (*Peryphus*) *charile*, Bates, *l. c.* p. 79.
Christchurch (*Mr. Fereday*).

I have not again received either of the above species. They form a distinct section, near *Peryphus*, distinguished by the setiferous punctures of the fifth as well as the third interstice of the elytra. In form they closely resemble the European *B. eques*; but the thorax is smaller and still more cordate (similar to that of the *Lopha* section). The frontal furrows are deep, and reach to the level of the hind margin of the eyes. The fovea of the hind angles of the thorax has no carina exterior to it. The anterior tarsi of the male have only the basal joint dilated, parallelogrammical, as in *Peryphus eques*.

Bembidium rotundicolle, n. sp.

B. nilotico similis, cupreo-æneum, nitidum; antennis basi pedibusque piceo-rufis; elytris utrinque versus apicem, ipsoque apice flavo-testaceis; thorace fortiter rotundato, basi angusta, marginibus angustis, postice nullomodo explanatis, angulis posticis vix conspicuis, fovea parva juxta angulum lævi; elytris punctato-striatis, extus, et apice minus impressis, interstitiis paulo convexis, tertio bipunctato. Long. $1\frac{3}{4}$—2 lin. M.

M. Tarsi antici articulis duobus dilatatis, apice obliquis et fortiter intus productis.

Differs from the section to which *B. niloticum* belongs by the very narrow margins to the thorax, not explanated behind, and with obtuse hind angles; the sides of the thorax are very strongly rounded, but the base is much narrower than the apex; the apical angles are not at all conspicuous.

Lake Coleridge; under stones in a dry lagoon (*C. M. Wakefield, Esq.*).

Subfamily ACTENONYCHINÆ.

Actenonyx bembidioïdes, White, *l. c.* p. 2 (1846).

Sphallax peryphoïdes, Bates, Ent. Monthly Mag. iv. p. 56 (1867).

Christchurch (*R. W. Fereday, Esq.*).

White's description omits all the essential characters of this curious Carabid, and is so vague that there are no means of identifying it without reference to the type. I have seen a specimen so named in the British Museum, which quite agrees with *Sphallax peryphoïdes*. The extraordinary form of the ligula, and other characters, necessitate the formation of a new subfamily for the insect, which will range near the *Odacanthinæ*.

Subfamily SCOPODINÆ.

Scopodes fossulatus.

Dromius (!) *fossulatus*, Blanch. Voy. Pôle Sud, iv. p.9, t.iii. f.16.
Periblepusa elaphroïdes, Redtenb. Reise Novara, Col. p.21, t.i. f.9.

Blanchard's description accords exceedingly well with a species apparently common at Auckland, with the exception that no mention is made of the prominent eyes; this omission, however, is supplied to some extent by his figure.

Auckland. Both from Mr. H. Edwards and Mr. Lawson.

A well-preserved specimen, rather larger than usual, agrees exactly with Redtenbacher's description.

Scopodes elaphroïdes.

Helæotrechus elaphroïdes, White, *l. c.* p.5, t.i. f.5.

Larger than the preceding ($2\frac{1}{2}$ lines), and differing besides in being "deep black," *S. fossulatus* being silky æneous; the legs are "yellow, with middle of femora and the tips with a brownish band."

Scopodes aterrimus, n. sp.

S. magis elongatus, gracilior, toto insecto sericeo-niger; thorace angustiore, ab angulo anteriore usque basin recte angustato, supra subtiliter strigoso sed nitido; elytris striis latis paulo undulatis, impunctatis, foveis tribus magnis prope suturam alterisque irregularibus versus apicem. Long. 2—$2\frac{1}{4}$ lin.

Distinguished from *S. fossulatus* and from all the Australian species known to me (nine in number) by the form of the thorax—rather narrow, with slightly prominent antero-lateral angles, and without trace of posterior angle, the lateral margin being rounded off to the base; the surface is rather faintly transversely strigose and shining.

Two examples from Mr. H. Edwards (Auckland), and one from Christchurch (Mr. Fereday).

Subfamily Coptoderinæ.

Agonochila binotata.

Lebia binotata, White, *l. c.* p. 2.

Gomelina binotata, Blanch. Voy. Pôle Sud, iv. p. 12 (1853).

Agonochila binotata, Chaud. Bull. Mosc. (1848).

Coptodera (*Agonochila*) *antipodum*, Bates, Ent. Monthly Mag. iv. (1867), p. 78.

Sarothrocrepis binotata, Redtenb. Reise Novara, Coleop. p. 7.

Christchurch.

Subfamily Calleidinæ.

Demetrida linealla, White, Zool. Ereb. and Terr., Ins. p.2, t.i. f.3.

Port Nicholson.

Demetrida nasuta, White, *l. c.* p. 2.

Auckland (*H. Edwards, Esq.*).

Demetrida picea.

Demetrida picea, Chaud. Bull. Mosc. 1848, i. p. 77; Ann. Soc. Ent. Belg. tome xv. p. 195 (1872).

Cymindis australis, Hombr. and Jacq. Voy. Pôle Sud, Zool. t.i. f.7 (1842?).

Cymindis dieffenbachii, White, Dieffenb. New Zeal. vol. ii. p. 273 (1843); Blanch. Voy. Pôle Sud, Zool. iv. (1853).

Christchurch (*Mr. Fereday*).

Chaudoir's name must remain for this species, according to the rule that the first unoccupied name accompanied by a description takes the priority. The figure in the "Voyage au Pôle Sud" was published eleven years before the description, and was erroneously lettered *C. australis*, not being the *C. australis* of Dejean. Blanchard himself corrected this error in 1853; but long before that date Chaudoir's excellent description had appeared. White's name was simply given (without description) to the above-mentioned figure, in place of the erroneous *C. australis.*

Species of doubtful position.

Pedalopia novæ-zealandiæ, Castelnau, *l. c.* p. 154.

ART. XLVI.—*On the Longicorn* Coleoptera *of New Zealand.*

By H. W. BATES, F.L.S.

[*From the Ann. and Mag. Nat. Hist., July and August,* 1874.]

THE number of new genera and species of Longicorn Coleoptera described in the following pages, chiefly obtained, without their devoting especial attention to the family, by two gentlemen (Mr. Lawson and Mr. Fereday) in the immediate neighbourhoods of the settlements where they are located, shows how much yet remains to be done before we can be said to have a satisfactory knowledge of the insect-fauna of New Zealand. The representatives of this almost exclusively wood-eating coleopterous family are evidently much more numerous in species there than in the British Isles, 57 being already known; whereas in Britain we have only 56, a number not likely to be increased by future researches. It would be proper, doubtless, to withdraw from the New Zealand list four of the species as being evidently introduced (three from Australia and one from Europe), thus leaving 53 only; but, on the other hand, several undescribed species exist in private collections.

The remarks I had occasion to make in a former paper on the family Geodephaga, as to the strong endemicity of the New Zealand Coleopterous fauna, are more than justified by the subsequent study of the family Longicornia. A close and repeated examination of all parts of the external structure, which afford characters for judging on the affinity of forms in this difficult group, has resulted in showing that very few indeed of the New Zealand genera are found in other parts of the world. Out of the total number of 35, no fewer than 26, as far as at present known, are peculiar to the islands; and about a dozen of these have no near relationship to forms occurring elsewhere, the rest being more or less related to genera found in Lord Howe's Island, New Caledonia, and Australia. It is in these two latter countries that seven of the other nine genera occur, one only of them (*Demonax*) extending its range through the Moluccas to South-eastern Asia. As to species, all, except one (*Hylotrupes bajulus*) introduced from Europe and three introduced from Australia, are peculiar to the islands.

COLEOPTERA LONGICORNIA.

Family Prionidæ.

Prionoplus reticularis.

Prionoplus reticularis, White, Dieffenbach's 'New Zealand,' ii. p. 276; Westwood, Arcana Entomologica, ii. p. 25, t. 56. f. 1.

Northern and Southern islands.

Family **Cerambycidæ.**

Division 1. *Eyes coarsely faceted.*

Phoracantha dorsalis, Newm.

I have not seen any specimen from New Zealand of this well-known Australian insect. White gives it on the authority of Dr. Sinclair.

Liogramma, nov. gen.

Ad. gen. *Phacodes* et *Elaphidion* affine, sed antennis articulo tertio apice intus acute producto, articulis reliquis simplicibus. *Corpus* lineare, paulo convexum, nitidum sed passim pubescens. *Caput* retractum ; oculi prominuli, grossissime granulati ; frons brevis ; palpi breves, articulis terminalibus triangularibus. *Antennæ* M. corpore paulo longiores, pilosæ, haud sulcatæ, scapo curvato-clavato, articulo tertio apice intus acute dentato, quarto quam tertio paulo breviore, quinto usque undecimum æqualibus, precedente longioribus, gradatim attenuatis. *Thorax* oblongus, postice vix angustatus, lateribus paulo rotundatis inermibus, supra rugosis, lineis elevatis politis. *Elytra* thorace vix latiora apice late rotundata. *Pedes* modice elongati, femora gradatim clavata ; tibiæ haud sulcatæ ; tarsi breves, articulo primo modice elongato. *Acetabula* antica postice aperta, extus vix angulata, prosterno angusto, marginato ; intermedia extus clausa.

This new genus is founded on *Callidium zealandicum*, Blanch., an insect having no near affinity to *Callidium*, but which Lacordaire was inclined to place in *Callidiopsis*, and White included in *Œmona*. It differs in essential characters from all these groups, and seems most nearly allied to the American genus *Elaphidion*.

Liogramma zealandicum.

Callidium zealandicum, Blanch. Voyage au Pôle Sud, Zool. iv. p. 272, pl. 17. f.4.
Callidiopsis zealandicus, Lacordaire, Gen. ix. p. 357, note.

Rusty brown in colour, with paler pubescence ; the smooth streaks on the thorax consist of a dorsal line and two discoidal ones on each side, the inner of which is connected with a rounded tubercle, and the outer short and sometimes obsolete ; the elytra are rugose-punctate throughout.

Sent in some numbers by Mr. Wakefield, with a note attached—" Under bark, Akaroa."

Didymocantha sublineata.

Eburida sublineata, White, Voy. Ereb. & Terr. p. 19.
Didymocantha sublineata, Lacord. Gen. ix. p. 344.
Auckland and Port Nicholson.

Didymocantha picta, n. sp.

D. modice convexa, breviter erecte pubescens, castaneo-fusca ; elytris nitidis, apice conjunctim rotundatis, rugoso-punctatis, utrinque maculis quatuor

fulvis; thorace spina laterali et tuberculis quinque dorsalibus, interstitiis grosse punctatis; scutello albo; antennis pedibusque castaneo-rufis. Long. 6 lin.

New Zealand. Received from Dr. Baden of Altona.

This species has some points, such as the distinctly clavate femora and tuberculate thorax, in common with the genus *Ambeodontus*; but the form of the muzzle (very short, not tapering, and with produced acute anterior angles), the antennæ, and the palpi are different, and show a nearer affinity with *Didymocantha.*

The head is slightly exserted, coarsely punctured, with prominent eyes and short palpi. The antennæ are pubescent throughout, with the fourth joint distinctly shorter than the third, and much shorter than the fifth. The thorax is much narrower than the elytra, with the lateral spine placed much behind the middle, and five tubercles on the disc, three only of which are much elevated; the depressed parts are covered with round punctures. The fulvous spots on the elytra are:—one, rounded, basal; a second, elongated, behind the shoulder; a third, irregular, meeting the corresponding one on the suture in the middle; and a fourth, small, discoidal, before the apex.

Didymocantha diversicornis.

Callidium diversicornis, White, Voy. Ereb. & Terr. p. 20.

The type (a damaged specimen) in the British Museum resembles much *D. picta*, and is congeneric with it. It has, however, more numerous yellow spots on the elytra.

Œmona hirta.

Saperda hirta, Fab. Syst. Entom. p. 184.
Saperda villosa, Fab. Syst. Eleuth. ii. p. 320.
Œmona humilis, Newm. Entom. p. 8 (1840).
Isodera villosa, White, Voy. Ereb. & Terr. p. 21, t.4. f.1. (1846).

Auckland, apparently not uncommon.

Leptachrous, nov. gen.

Genus *Phlyctænodi* affine, a quo differt capite ante oculos magis elongato, quadrato, palpis gracilibus filiformibus etc. *Corpus* elongatum, gracile. *Caput* exsertum, antice paulo elongatum, lateribus parallelis; tubera antennifera fortiter oblique elevata. *Palpi* articulis terminalibus haud dilatatis. *Antennæ* subtiliter ciliatæ, scapo gracili, clavato, quam articulo tertio vel quarto longiore; articulus quintus precedente et sequente longior. *Thorax* antice constrictus, supra inæqualis, haud distincte tuberculatus, spina laterali validissima. *Elytra* costata, apice acute rotundata. *Pedes* modice elongati; femora vix incrassata. *Prosternum* inter coxas exsertas angustum; acetabula intermedia extus aperta.

Founded on *Cerambyx strigipennis*, Westwood, which White referred with doubt to *Phlyctænodes*, but which differs in all essential points from that

genus. The much shorter maxillary palpi, long square muzzle, and elongated scape are the most obvious structural peculiarities.

Leptachrous strigipennis.

Cerambyx strigipennis, Westw. Arc. Ent. ii. p. 27, pl. 56. f.6.

Port Nicholson. Christchurch.

Ambeodontus tristis.

Saperda tristis, Fab. Syst. Entom. p. 186.

Phlyctænodes trituberculatus, Redtenb. Reise Novara, Col. p. 188.

Three examples received from Mr. Fereday, of Christchurch, belong undoubtedly to the same species as the type specimen of *Saperda tristis* still preserved in the Banksian collection at the British Museum. They agree also well with Redtenbacher's description cited above.

Ambeodontus retiferus, Lacord. Gen. ix. p. 374 (note).

Agapanthida pulchella, White, Voy. Ereb. & Terr. p. 22, pl. 4. f.10.

Placed by Lacordaire near *Phlyctænodes.*

Ophryops pallidus, White, Voy. Ereb. and Terr. p. 19, pl. 4. f.8.

Port Nicholson. I have not been able to examine the type of this and the preceding species.

ASTETHOLEA, nov. gen.

Corpus lineare, depressum, fere glabrum. *Caput* breve, rotundatum, exsertum, inter antennas latum, planum, post oculos gradatim angustatum, genis brevibus haud angulatis. *Antennæ* breviter pubescentes, scapo gradatim clavato, articulo tertio quam scapo vel articulo quarto breviore. *Oculi* magni, reniformes, grosse granulati, supra longe distantes. *Thorax* rhomboideus, planatus. *Elytra* linearia, apice obtuse rotundata. *Pedes* modice elongati; femora gradatim incrassata. *Coxæ* anticæ conicæ, contiguæ, exsertæ, prosterno ante coxas truncato; coxæ intermediæ contiguæ, mesosterno antice triangulari, inter coxas haud continuato. *Abdomen* (F.) normale.

This is another of the anomalous forms of Longicornia, of which there are so many in Australia and New Zealand. Its nearest ally seems to be *Tricheops*; but the head is nearly plane between the antennæ, and the antenniferous tubers are almost horizontal, with a continuous impressed dorsal line.

Astetholea pauper, n. sp.

A. fulvo-testacea, glabra, pedibus pallidioribus; capite thoraceque lævibus subsericeis, hoc medio utrinque angulari haud spinoso; elytris punctulatis, utrinque bicostulatis, apud latera at apicem lævibus. Long. 3¼—4 lin. M. F.

Linear and depressed, nearly glabrous, but moderately shining. The head and thorax in their wider parts are as broad as the elytra; the latter are

smooth on the sides (which are vertical) and near the apex, but punctulate and with two raised discoidal lines from the base to beyond the middle.

Auckland (*Mr. Lawson*); three examples.

Blosyropus spinosus, Redtenb. Reise Novara, Col. p. 192, t.v. f.10.

The author does not specify the structure of the eyes, so that it remains uncertain whether this large and remarkable Longicorn belongs to this or the following division. The form of the head, according to the figure, much resembles that of *Astetholea.*

Psilomorpha tenuipes, Saunders, Trans. Ent. Soc. 2nd ser. i. p. 80, t.4. f.1.

Found in New Zealand, according to Redtenbacher (Col. Novara, p. 188).

Division 2. *Eyes finely faceted.*

Stenoderus suturalis, Oliv.

Recorded by Redtenbacher as taken in New Zealand.

Callipráson sinclairi.

Calliprason sinclairi, White, Dieffenb. New Zeal. ii. p. 277; Westw. Arc. Ent. ii. p. 27, t.56. f.3.

Calliprason marginatum, White, Voy. Ereb. & Terr., Ins. p. 23, t.4. f.6.

The exact locality of neither of these two species is recorded, and I have not yet seen examples of them.

Zorion minutum.

Callidium minutum, Fab. Syst. Ent. p. 192.

Obrium fabricianum, Westw. Arc. Ent. ii. p. 28.

I have seen a large number of specimens from Auckland. Amongst them are several varieties, in one of which the white elytral fascia is reduced to a round spot margined with violet, and the pale bases of the femora are terminated by a dusky ring.

Zorion guttigerum, Westw. Arc. Ent. ii. p. 28, t. 56, f. 4.

Port Nicholson.

A specimen from Mr. Lawson, taken near Auckland, differs from Westwood's description by having the head and greater part of the thorax testaceous yellow, nearly as in *Z. minutum*; the tibiæ and tarsi are also violet-brown, like the clubs of the femora. It remains with New Zealand coleopterists to decide by observation on the spot whether these diversities of colouration really indicate specific differences, and whether there are really more than one variable species in the islands.

GASTROSARUS, nov. gen.

Corpus lineare, nitidum, sparsim erecte pubescens. *Caput* exsertum, post oculos paulo angustatum sed haud elongatum; frons brevis, verticalis. *Oculi* magni, modice convexi et granulati, laterales, supra distantes. *Palpi* paulo

elongati, articulis terminalibus vix dilatatis oblique truncatis. *Antennæ* basi distantes, haud ciliatæ; scapo et articulis tertio et quarto æqualibus, brevibus, quinto usque undecimum paulo longioribus. *Thorax* rhomboideus, lævis. *Elytra* linearia, utrinque postice leviter attenuata, apice acute truncata, supra fere lævia. *Prosternum* inter coxas angustum; mesosternum oblongum; metasterni episterna fere parallela, apicem versus tantum angustata; acetabula antica et intermedia extus paulo aperta. *Abdomen* (F.) lineare, elongatum; segmentis primo usque quartum normalibus, quinto ventrali late excavato et dense atque longe piloso; pygidio valde convexo et arcuato. *Pedes* robusti; femora gradatim incrassata; tarsi breves, posticorum articulo primo vix secundo tertioque conjunctim longiore.

Another anomalous genus, having no near affinity with any other known form; it seems, however, to come nearest such genera as *Callimus*, and especially the Australian *Earinis.* I know only the female, which differs from the same sex in *Earinis* in the concentration of the hairiness of the abdomen on the fifth ventral segment and on the arched borders of the pygidium. The form of the metathoracic episterna is very similar to that of *Earinis*, as is also the thorax—oblong, with an angular dilatation in the middle of each side. The head and thorax together are small relatively to the rest of the body. The antennæ (F.) are not much more than three-fourths the length of the body.

Gastrosarus nigricollis, n. sp.

G. violaceo-nigra, nitida; ore, pedibus, abdomine et elytris fulvo-testaceis, his apice violaceis. Long. 5½ lin. F.

The head is sparingly but strongly punctured, except the middle of the crown, which is convex and glossy. The thorax is small, very faintly punctured, and with a tranverse depression near the anterior and posterior margins. Each elytron tapers gradually from base to apex, the latter being broadly and sharply truncated, and not reaching the tip of the abdomen; the surface is glossy, and bears only a few punctures, strongest near the base.

One example. Christchurch (*Mr. Fereday*).

Eburida sericea, White, Cat. Long. Col. Brit. Mus. p. 299.

Waipa River.

The type specimen of this insect in the British Museum has no resemblance whatever to *E. sublineata*, with which White associated it, and which has been found to belong to *Didymocantha*. *E. sericea* has finely faceted eyes and broadly angulated anterior acetabula, and will therefore find its proper place in the *Callidiinæ*; it will probably remain a distinct genus, but I am doubtful whether White's name can properly be applied to it.

Hylotrupes bajulus, L.

Two specimens taken by Mr. Lawson at Auckland, differing in no respect from the European insect. Evidently introduced.

Demonax spinicornis.

Clytus spinicornis, Newm. Zoologist, 1850, Suppl. p. cxix.; White, Cat. Long. Col. Brit. Mus. p. 286.

New Zealand. I have not seen this species.

Coptomma variegatum.

Callidium variegatum, Fab. Syst. Ent. p. 189.

Coptomma virgatum, Newm. Ann. & Mag. Nat. Hist. v. 1840, p. 18.

Northern and Southern islands.

Navomorpha lineatum.

Callidium lineatum, Fab. Syst. Ent. i. p. 189.

Coptomma lineatum, White, Voy. Ereb. & Terr., Ins. p. 20, t.4. f.5.

Navomorpha sulcatum.

Callidium sulcatum, Fab. Syst. Ent. i. p. 189.

Coptomma acutipenne, White, *l. c.* t.4. f.2.

I have examined Fabricius's type in the Banksian collection, and fail to detect any difference between it and the *acutipenne*, White.

Auckland; Christchurch.

Family **Lamiadæ.**

Hexatricha pulverulenta.

Lamia pulverulenta, Westw. Arc. Ent. ii. p. 26, t. 56. f. 5.

Hexatricha pulverulenta, White, Voy. Ereb. and Terr., Ins. p. 21.

Waikouaiti; Port Nicholson.

Xylotoles lynceus.

Saperda lynceus, Fab. Syst. Ent. p. 185.

The specimen of this insect still preserved in the Banksian collection, though in bad condition, is recognizable as a species of *Xylotoles*, and doubtless a male; but I have seen no second example of the species, among the hundreds of specimens of *Xylotoles* sent home by Mr. Lawson from Auckland and a smaller number by Mr. Fereday from Christchurch. It is remarkably elongate and parrallel-sided, $5\frac{1}{2}$ lines long, with the apices of the elytra produced and divaricate; in colour it resembles *X. griseus.*

Xylotoles griseus.

Xylotoles griseus, Westw. Arc. Ent. ii. p. 27, t. 56. f.2.

Saperda grisea, Fab. Syst. Ent. p. 186.

Lamia heteromorpha, Boisd. Voy. de l'Astrolabe, Ent. ii. p. 505, t.9. f.14.

Xylotoles lentus, Newm. Entom. p. 12.

Xylotoles westwoodii, Guér. Rev. Zool. 1847, p. 170.

The descriptions of Boisduval and Newman agree very well with a common species, to which the type of Fabricius belongs. Mr. Lawson has sent it in great numbers from Auckland, and I have also received it from Christchurch. It varies in size from 3 to 6 lines; and the apices of the elytra are singly rounded in both sexes (rather more acutely in the male), never divaricated.

The shape of the body is elongate-elliptical, the elytra at the shoulders being scarcely wider than the base of the thorax. The colour of the integument is coppery brown, but veiled with a laid ashy pubescence, never dense enough wholly to conceal the ground-colour—fresh examples showing, besides, a few condensed white linear spots, placed some on the anterior disk and others as an oblique macular fascia behind the middle; but these spots are sometimes wanting. The elytra are faintly striated (except the sutural stria), and have a number of large punctures arranged in irregular rows near the base. The antennæ are pitchy red, with the bases of some of the joints paler.

Xylotoles humeratus, n. sp.

X. griseo proxime affinis; magnis nitidus; elytris ad humeros thoracis basi distincte latioribus, humeris rectangulatis, maculis pubescentibus fulvis; oculis pilis fulvis marginatis. Long. 3—5 lin. **M. F.**

Difficult at first sight to distinguish from *X. griseus*, but certainly distinct. The difference in general form first strikes the eye—a difference which arises from the thorax being much shorter and more narrowed at the base, and from the elytra at the base being much wider, with wide outstanding rectangular shoulders. The colour is also constantly different, being more brassy greenish and shining, especially on the thorax. The general laid pubescence is greyish, and the striæ and punctures are nearly the same as in *X. griseus*; but the denser pubescent spots are always orange-tawny and conspicuous, arranged in two groups—one near the base (some of them forming an oblique line), and the other behind the middle (forming a line oblique in the opposite direction to the former). The orbit of the eyes has also a dense fringe of the same tawny-coloured hairs; and there is a patch of the same on each side of the thorax.

Many examples from Mr. Lawson of Auckland, mixed with *X. griseus*.

Xylotoles subpinguis, White, Voy. Ereb. and Terr. p. 22.

One example from Mr. Fereday, Christchurch, agreeing well with White's description.

The species much resembles *X. griseus*, but has a more spotty pubescence and the elytra are more prolonged and pointed at the apices (**M.**)

Xylotoles nudus, n. sp.

X. elongatus, angustus, cuprascenti-niger, glaber, nitidus; elytris basi thorace vix latioribus, apice utrinque productis et paulo divaricatis, basi grossissime lineatim punctatis; antennis pedibusque castaneis; femoribus obscurioribus. Long. 4¼—5 lin.

Body entirely destitute of pubescence, except spots on the sides of the ventral segments; antennæ and legs finely griseous pubescent. Colour glossy coppery black; head and thorax impunctate and smooth. Elytra elongated,

not perceptibly broader at the base than the thorax, very slightly bulging in the middle, and gradually narrowed and prolonged at the apex, where they are slightly divaricate; the surface has rows of very large punctures, from the suture to the sides and extending to the middle.

Several examples sent from Auckland by Mr. Lawson.

Xylotoles rugicollis, n. sp.

X. fusco-niger, subæneus, nitidus; thorace elongato-quadrato, supra passim transverse rugato; elytris ellipticis, apice utrinque productis, acutis, supra striatis interstitiis elevatis, fulvo-guttatis; antennis pedibusque castaneis. Long. 4—6 lin. **M. F.**

Distinguished by the thorax being elongate-quadrate in outline, a little dilated immediately behind its anterior angles, where it is widest, and covered with irregular transverse wrinkles. The sides have some patches or lines of tawny pubescence, as well as the front of the head. The elytra have no distinct shoulders, and are dilated in the middle, whence they taper gradually to the pointed apices, most prolonged in the male, but not divaricate; their surface is coarsely sculptured, deeply striated almost to the apex, and marked with large punctures. The underside is very glossy, with spots of tawny tomentum on the sides of the breast and abdomen.

Auckland (*Mr. Lawson*); a few examples.

Xylotoles lætus, White, Voy. Ereb. and Terr., Ins. p. 22.

This species (if I refer it correctly to White's *X. lætus*) is shorter and much more ovate than its allies, the apices of the elytra not being produced, but somewhat obtusely rounded together. The colours are more gaily metallic. White describes the thorax as violet, and the elytra green; but in a larger series many varieties are seen, some being wholly brassy green, others coppery or violaceous; the thorax and elytra concolorous or not. The elytra are narrow and rounded at the shoulders. The thorax has a few coarse rugæ on the sides; but is nearly smooth on the disk.

Auckland (*Mr. Lawson*); several examples, measuring from $2\frac{3}{4}$ to $4\frac{1}{4}$ lines in length.

Xylotoles nanus, n. sp.

? *Xylotoles parvulus*, White, Voy. Ereb. & Terr., Ins. p. 22.

Similar in form to *X. griseus*, but much smaller and more densely clothed with spotty or lineated griseous pubescence, with darker spots on the elytra, forming in well-preserved examples a somewhat tessellated pattern, the dark colour often concentrating in a patch on each side of the elytra. The thorax is very similar in form, but the two transverse impressed lines are less marked. The elytra are very nearly of the same width at the shoulders as the base of the thorax, their apices are not prolonged but singly rounded, and they have

an irregular number of punctures near the base arranged in rows; they are destitute of impressed striæ, except the usual sutural one.

A further distinction from *X. griseus*, even the smallest examples, is the colour of the antennæ, the apices of the joints being always distinctly fuscous or black.

The general ground-colour is extremely variable, from brown with a scarcely perceptible brassy tinge to dull tawny or pale testaceous. Long. 2—2¾ lin.

Auckland. Mr. Lawson has sent home a very large number of this small, variable species.

White's description (!) of his *X. parvulus* consists of the following words:—"Testaceous, covered with a greyish pubescence; base of elytra with several dots and four rows of small punctures in two lines, extending to the middle of elytra." No size is given; and the description applies equally well to our *X. ægrotus*.

Xylotoles ægrotus, n. sp.

X. elongatus, angustus, omnino fulvo-testaceus, subtiliter griseo-pubescens; elytris M. apice dehiscentibus, singulatim prolongatis, perparum divaricatis, F. acute conjunctim rotundatis. Long. 2½—2¾ lin.

Similar in form to *X. nanus*, but always of a tawny testaceous colour, with fine scant grey pubescence, arranged more or less in lines on the elytra. The antennæ are not ringed with dark colour, but pallid like the rest of the body, or at most a little browner at the extreme tips of some of the joints. The elytra are relatively much longer and are narrowed and prolonged towards their apices; in the male strongly dehiscent at the suture; they are a little wider at the base than the base of the thorax, and have the usual lineated punctuation from the base to the middle. The sutural stria is deeply sunk.

Auckland, six examples (*Mr. Lawson*); Christchurch (*Mr. Fereday*), three examples.

The punctuation at the base of the elytra varies considerably. In some specimens there are only two simple rows of punctures; but in others there are two or three rows, each composed of a large number of punctures, arranged often without order. The difference is not sexual, but the two varieties are strongly pronounced.

Xylotoles pulchellus, n. sp.

X. nano proxime affinis, at differt elytris magis ellipticis fusco fasciatis, corpore subtus dense cinereo-tomentoso. Parvus, nigrocupreus, alutaceus, pube grisea vestitus; elytris ad humeros angustis, regulariter ellipticis, apice conjunctim subacute rotundatis, plagis fuscis magnis duabus fasciiformibus, altera pone medium, altera apicali. Long. 2¼ lin.

Closely resembling *X. nanus*, but the elytra decidedly more elliptical in form, *i.e.* narrower at the shoulders and more regularly rounded on the sides, the apex being jointly rounded; the surface is of the coppery black or dark brown of the full-coloured examples of *X. nanus*; and the grey pubescence is spotty in the same way on the elytra; but the dark patches lie in two places, forming irregular broad fasciæ, one at the middle and the other at the apex. The antennæ are rather more slender, and have a larger portion of the apices of the joints pitchy black. Beneath, the insect is more densely clothed with grey pubescence.

Christchurch (*Mr. Fereday*); one example.

Xylotoles scissicauda, n. sp.

X. elongato-ellipticus, castaneo-fuscus, griseo-pubescens; thorace medio utrinque dilatato-tumido, supra sulcis duobus transversis fortiter impressis, alteroque dorsali, basi subtiliter transversim multistrigoso; elytris humeris paululum productis, obliquis, postice gradatim attenuatis, apice dehiscentibus ibique sutura emarginata, supra fere ad apicem lineatim punctatis, costulisque utrinque tribus. Long. 3½—4 lin.

This very distinct species may be recognized at once by the thorax—tumid, almost tubercular in the middle on each side, with the anterior and posterior transverse sulci deeply impressed and united in the middle by a longitudinal dorsal impressed line. The tubercle on each side is coarsely sculptured; and the basal surface is covered with a multitude of fine transverse striæ. The punctuation of the elytra extends nearly to the apex, and is interrupted by three raised costæ on each elytron; the apex is tapering, and the suture widely gaping, having on each edge a curved sinuation. The sides and apex of the elytra have a few whitish bristles. The legs are concolorous; the antennæ have a speckled pubescence and are robust.

Christchurch (*Mr. Fereday*); three examples. This species tends to connect *Xylotoles* with *Tetrorea.*

MICROLAMIA, nov. gen.

Gen. *Xylotoli* affine; differt antennis articulis brevibus, primo basi extus haud subito dilatato, femoribusque fortiter tumido-clavatis. *Corpus* minimum, longe hirsutum; elytris quam corpore anteriore haud longiore. *Elytra* basi transverse depressa, humeris rotundatis. *Thorax* magnus, lateribus tumidis. *Mesosternum* brevissimum. *Pro-* et *mesosterna* inter coxas latissima, plana.

Microlamia pygmæa, n. sp.

M. elongato-ovata, rufo-castanea nitida, antennis pedibusque pallidioribus, illis undique pilosis; capite punctato; thorace lateribus grossissime punctatis, disco lævissimo, sine linea dorsali, basi et apice transversim strigoso; elytris sparsim, basi densius punctatis, apice subabrupte declivibus. Long. 1½ lin.

This curious and minute Longicorn in the proportions of its body resembles the genus *Deucalion* rather than *Xylotoles*; but the thorax is unarmed at the sides. The basal joint of the antennæ forms a pyriform club, as in the genus *Blax*. Its chief peculiarities reside in the great width of the pro- and mesosterna between the coxæ, and in the very thick clavate thighs, also in the robust filiform antennæ—not ciliated, but hairy on all sides, and with rather short joints, the third and fourth not much longer than the rest.

Auckland (*Mr. Lawson*); one example.

SOMATIDIA, Thomson, Syst. Ceramb. p. 39.

Gen. *Parmenæ* affine; differt thorace haud armato, femoribusque fortiter clavatis basi pedunculatis. *Corpus* ovatum, grosse punctatum. *Caput* inter antennas haud concavum. *Antennæ* filiformes, ciliatæ; scapo ovato, articulo tertio cæteris paulo longioribus. *Prosternum* inter coxas arcuatum. *Mesosternum* oblongum, declive. *Epimera* mesothoracica obliquaa, cetabula haud attingentia. *Tibiæ* intermediæ extus emarginatæ. *Ungues* divaricati.

Closely allied to the Mediterranean genus *Parmena*, and very similar in facies, except that the general form is shorter and more ovate.

Somatidia antarctica.

Parmena antarctica, White, Voy. Ereb. and Terr., Ins. p. 22.

The elytra have distinct, almost toothed humeral angles; but their outline is very oblique from the angle to the true base; each elytron has two small tufts of hair. Long. $2\frac{1}{2}$—3 lines.

Port Nicholson; also Auckland (*Mr. Lawson*).

Somatidia ptinoïdes, n. sp.

S. cupreo-fusca, fulvo-griseo pubescens, setosa; thorace ovato, crebre grosse punctato; elytris a medio usque ad basin fortiter angustatis humeris nullis, macula utrinque exteriore basali, fascia mediana maculaque apicali suturali nigris, penicillis nullis; antennis et pedibus rufescentibus. Long. $1\frac{1}{2}$—$2\frac{1}{4}$ lin.

Auckland (*Mr. Lawson*); four examples. The fourth joint of the antennæ is very short.

STENELLIPSIS, nov. gen.

Corpus angustum, ellipticum, convexum, subtile tomentosum, læve. *Caput* exsertum, inter antennas modice late concavum, fronte quadrata. *Palpi* subelongati, robusti, articulis ultimis fusiformibus. *Thorax* transversus, antice et postice constrictus, medio convexo, lateribus tumidis, inermibus. *Elytra* convexa, prope basin transversim depressa, apice obtuse rotundata, fere truncata; stria suturali solum impressa, versus basin abbreviata. *Acetabula* antica et intermedia extus clausa. *Prosternum* inter coxas vix arcuatum, angustissimum, apice dilatatum; mesosternum oblongum, vix declive.

Mesothorax paululum abbreviatus. *Pedes* elongati; coxæ magnæ, globosæ; femora fortiter clavata; tibiæ intermediæ extus leviter emarginatæ; tarsi vix elongati, articulo primo cæteris subæquali; ungues divaricati. *Antennæ* corpore triente longiores, graciles, sparsim ciliatæ; articulo primo basi extus subito sed modice dilatato, cæteris elongatis ab tertio gradatim brevioribus.

This genus has many of the peculiar characters of *Xylotoles*, and is evidently allied to it; but its facies is very different, resembling that of many *Acanthocininæ* (e. g. *Driopea*). The metathorax, without being conspicuously abbreviated as in the *Dorcadioninæ*, is so much shortened that the distance between the middle and posterior coxæ is somewhat less than that between the anterior and the middle. The prosternum also, although very narrow between the coxæ, is nearly plane as in *Xylotoles*. The head is of precisely the same shape.

Stenellipsis bimaculata.

Xylotoles bimaculatus, White, Voy. Ereb. and Terr., Ins. p. 22.

White's description, though brief, is sufficient to enable us to recognize his species, as he mentions the "bulging middle of the thorax," the anterior and posterior transverse impressions of the same part, and the tomentose yellow spot in the depressed part near the base of each elytron.

Auckland. Sent sparingly by Mr. Lawson.

Stenellipsis gracilis.

? *Xylotoles gracilis*, White, Voy. Ereb. and Terr., Ins. p. 22.

The above-cited description of this species leaves us in doubt whether it applies to our insect, as no mention is made of the "bulging" middle of the thorax, although it is as conspicuous as in the allied *S. bimaculata*. The elytra are more cylindrical and less ovate than in *S. bimaculata*, and are clothed with fine grey tomentum, prettily spotted with brown, and having a brown fascia across the middle and a streak of the same colour behind, near the suture.

Auckland. Several examples sent by Mr. Lawson.

Stenellipsis latipennis, n. sp.

S. latior, elytris oblongo-ovatis, ad humeros thoracis basi fere duplo latioribus. Chalybeo-nigra, subtiliter cinereo-pubescens, antennis (scapo excepto) tibiisque basi et unguibus castaneis; thorace breviore, medio rotundato, lævi; elytris cinereis, guttis majoribus rotundis lineatim ordinatis, ad basin, in medio et versus apicem in plagas aggregatis. Long. 3 lin.

A true *Stenellipsis*, although differing from its congeners by the broader shoulders of the elytra; the latter have an obtuse elevation near the scutellum and a few punctures arranged in rows; with this exception the body is smooth and clothed with very fine laid pile, as in the other species.

Auckland (*Mr. Lawson*); one example.

Psilocnæia, nov. gen.

Gen. *Xylotoli* affine, sed corpore lineari, et metasterno haud abbreviato. Linearis, subdepressa. *Antennæ* corpore paulo longiores; articulo primo basi extus subito dilatato, tertio et quarto cæteris multo longioribus. *Caput* exsertum, inter antennas vix concavum. *Thorax* fere cylindricus, inermis. *Elytra* humeris valde obliquis, apice singulatim rotundata. *Prosternum* inter coxas ut in *Xylotole* planum, apice fortiter dilatatum. *Acetabula* antica extus haud angulata; intermedia extus clausa. *Femora* gradatim incrassata. *Tibiæ* intermediæ extus emarginatæ. *Ungues* divaricati.

This genus partakes of the character of *Xylotoles* and *Tetrorea*, and is equally allied to both these genera, which have been placed by Lacordaire in two widely separated subfamilies.

Psilocnæia linearis, n. sp.

P. linearis, pube adpressa cinerea vestita; elytris plaga utrinque laterali fusca, interdum obsoleta, basi sparsim lineatim punctatis, stria suturali fortiter impressa. Long. $2\frac{1}{2}$—$3\frac{1}{2}$ lin.

The ground-colour, visible only on portions of the thorax and head and in abraded parts, is of the same coppery brown as prevails in the genus *Xylotoles*; the head is of precisely similar form. The transverse impressions of the thorax are only vaguely marked; the fuscous lateral streak on each elytron is generally varied with grey spots, and is sometimes reduced to a few dark lineated spots, or disappears altogether; the legs and antennæ are partly reddish testaceous; the pubescence of the thorax is somewhat lineated and denser on the sides.

Auckland. Mr. Lawson has sent home a very large number of specimens.

Spilotrogia, nov. gen.

Gen. *Stenellipsi* affine, sed facies multo diversa. Cylindrica, subtilissime pubescens. *Antennæ* graciles, corpore duplo longiores, vix pubescentes; scapo basi extus gradatim dilatato. *Caput* inter antennas concavum, fronte infra paulo angustata. *Thorax* cylindricus. *Elytra* cylindrica, basi thorace distincte latiora, humeris fere rectangulis, apice declivia obtuse rotundata, supra prope basin transversim depressa, stria suturali solum distincta. *Pro-* et *mesosterna* angusta, plana. Cætera ut in *Stenellipsi*.

Belongs to the same group as *Stenellipsis*, from which it differs in the mesosternum between the coxæ being nearly as narrow as the prosternum, and in the thorax and elytra being cylindrical; the metathorax appears somewhat shortened, the distance between the anterior and middle coxæ being no less than that between the middle and the hind pair.

Spilotrogia maculata, n. sp.

S. ochraceo-testacea, subnitida, capite thoracisque disco obscurioribus;

elytris castaneo-fusco maculatis, interdum plaga majore transversa communi pone medium. Long. $1\frac{1}{2}$—2 lin.

The maculation of the elytra is peculiar in this little Longicorn, as it is the derm and not the pubescence merely which is variegated in colour; the spots are very irregular, and lie chiefly near the suture, the yellow ground-colour prevailing on the sides.

Auckland (*Mr. Lawson*).

EURYCHÆNA, nov. gen.

Gen. *Enicodi* affinis, sed elytris M. haud prolongatis. *Corpus* parvum, sublineare, sericeo-pubescens. *Caput* subretractum, inter oculos latum, planum, ore (M.) latissimo, labro parvo quadrato, mandibulisque vix exsertis. *Antennæ* corpore vix longiores, graciles, sparsim ciliatæ; articulo primo subcylindrico, basi extus angustato, tertio et quarto modice elongatis. *Thorax* quadratus, inermis. *Elytra* apice singulatim rotundata, lateribus verticalibus; dorso planato, stria suturali solum impresso. *Pedes* parum elongati; femora clavata; tibiæ intermediæ extus emarginatæ; tarsorum ungues divaricati. *Metathorax* nullomodo abbreviatus. *Pro-* et *mesosterna* inter coxas angusta sed plana. *Acetabula* antica et intermedia extus clausa.

F. Capite antice haud dilatato, ore normali.

Belongs to the same group as the curious New Caledonian *Enicodes*, but differs totally from that genus in facies and in the narrow pro- and mesosterna. The head of the male is very similar, the orbit of the eyes being abruptly salient, and the mouth, though narrow, extremely broad; the eyes are simply reniform, with the upper portion rather narrow.

Eurychæna fragilis, n. sp.

E. fusco-testacea, pube subtili olivaceo-cinerea vestita, antennis pedibusque olivaceo-testaceis; thorace lævi, antice et postice transversim leviter impresso; elytris basi thorace latioribus, humeris exstantibus, supra, basa excepta, punctulatis; corpore subtus plus minusve rufo-testaceo. Long. $2\frac{1}{2}$—3 lin. M. F.

The elytra in the male taper a little towards the apex; in fine fresh examples they have a few dark brown spots and an oblique fascia of the same colour after the middle.

Auckland (*Mr. Lawson*).

Eurychæna feredayi, n. sp.

E. fragili similis, at differt colore obscuriore; elytris fusco-submaculatis; capite, corpore subtus, femoribus et tarsis nigro-fuscis; antennarum articulis apice fusco-maculatis. Long. $2\frac{1}{4}$ lin. F.

Christchurch (*Mr. Fereday*); one example.

Tetrorea cilipes, White, Voy. Ereb. & Terr., Ins. p. 21, t.4. f.9.

Auckland (*Mr. Lawson*).

HYBOLASIUS, nov. gen.

Gen. *Hebeseci* affine. *Corpus* oblongum, tomentosum. *Caput* retractum, fronte quadratum. *Antennæ* corpore paulo longiores, ciliatæ; scapo quam articulo tertio multo breviore, breviter clavato; articulis tertio et quarto cæteris singulis multo longioribus, hoc paulo curvato. *Thorax* lateribus tuberculatis. *Elytra* apice rotundata, basi utrinque cristata. *Pedes* robusti; femora clavata; tibiæ gradatim dilatatæ, intermediis vix emarginatis.

This genus is founded on a common New Zealand insect, the *Lamia crista* of Fabricius, which White placed in the genus *Pogonocherus*. It agrees with *Pogonocherus* in many essential characters—such as the structure of the sterna, the form of the sockets of the anterior and middle coxæ, and the divaricate claws; but the antennæ resemble much more nearly those of *Hebesecis* and the allied genera, differing chiefly in the shorter and more regularly clavate scape. There is, however, scarcely any difference in the formulæ given by Lacordaire of the two groups *Hebesecides* and *Pogonocherides*, although he places them so widely apart. The genus is also closely allied to the Chilian *Œctropsis*, placed by Lacordaire in the *Exocentrides* group.

Hybolasius crista.

Lamia crista, Fab. Syst. Entom. p. 170.

Fabricius describes the basal tubercles of the elytra as tridentate; but, as I have satisfied myself by examination of his type specimen in the Banksian collection, they are not toothed at all, but surmounted by a compressed pencil of hairs. This type is a large form of the species ($3\frac{3}{4}$ lines), of tawny brown colour, with the narrow black posterior fascia unaccompanied by a broader dark belt. Most of the examples I have seen (from Auckland) are smaller, about 3 lines, with much darker brown elytra, having the shoulders and an apical spot tawny, and a broad posterior blackish fascia, the anterior margin of which is black, margined again anteriorily with light tawny. But all connecting gradations occur, and I believe they form only one variable species. It may be known from its congeners by the elevated penicillated crests, the robust acute lateral thoracic tubercles, and the finely striated integument of the thorax.

Hybolasius viridescens, n. sp.

H. subdepressus, hirsutus, fuscus; elytris herbaceo-viridibus, medio dorsi fulvescentibus, strigaque obliqua nigra; thoracis tuberculis lateralibus magnis obtusis, dorso haud striato, medio trituberculato; elytris cristis basalibus parvis vix penicillatis, costa marginali altera flexuosa dorsali obtusis. Long. $2\frac{1}{4}$—$2\frac{1}{2}$ lin.

Auckland (*Mr. Lawson*).

Distinguishable from *H. crista* at once by the small basal crests of the elytra, which have a minute pencil of hairs, sometimes absent; the thorax has

not the finely sculptured transverse striæ of that species, and the lateral tubercles are not pointed. The elytra are depressed, coarsely and sparsely punctured, with a raised flexuous dorsal costa; their colour is brassy green, especially visible on the base and sides, the middle of the back being tawny with an oblique dusky belt, sometimes absent. The antennæ are much longer than the body, but of the same form and proportions as in *H. crista*, the cilia only being longer; they are dull reddish, varied with dusky.

Hybolasius simplex, n. sp.

H. gracilior, piceo-rufescens, sparsim griseo-pubescens; elytris subconfertim punctatis, haud costatis, cristis basalibus fere obsoletis, parum convexis, haud penicillatis; thorace angustiore, fere nudo, subtilissime et confertissime punctulato-rugoso, tuberculis lateralibus conicis. Long. $2\frac{1}{3}$ lin.

Auckland (*Mr. Lawson*); three examples.

Much more slender than *H. crista*, and less convex; distinguished also by the absence of penicillated crests, which are replaced by obtuse elevations. The general colour is pitchy or chestnut red, lighter on the antennæ, and darker on the undersides of the body and femora and at the apices of the tibiæ; the thorax is minutely sculptured throughout, and has rudiments of three small discoidal tubercles; the pubescence is very scant; the antennæ have the same form and proportions as in *H. crista*; and there can be little doubt of the near affinity of these two extreme species, notwithstanding the great difference in the elytral crests.

PŒCILIPPE, nov. gen.

Gen. *Nicippæ* et *Disternæ* prima facie simile, sed antennis basi haud approximatis, acetabulis intermediis fere clausis et elytris apice rotundatis. *Caput* ut in gen. *Hybolasio*, inter antennas concavum, fronte quadrata. *Antennæ* corpore longiores, graciles, ciliatæ; articulo primo quam tertio multo breviore, clavato, basi extus magis angustato, tertio et quarto cæteris singulis multo longioribus. *Thorax* brevis, antice et postice transversim fortiter impressus, medio utrinque tuberculo forti acuto armatus. *Elytra* elongato-subtrigona, modice convexa, tubere utrinque basali elevato. *Pro-* et *mesosterna* inter coxas angusta. *Acetabula* antica extus angulata, intermedia fere clausa. *Femora* clavata; tibiæ intermediæ extus perparum emarginatæ; tarsi breves, articulo primo omnium breviter triangulari. *Ungues* divaricati.

Although resembling the Australian *Disternæ* in general appearance, this genus differs much from them in structural characters and approaches much more nearly *Hybolasius*, the form of the scape of the antennæ being very nearly the same. The thorax, however, is much shorter, and has a far larger and more acute median spine. The apical ventral segment is much elongated and broadish at the apex in my single specimen; but I suspect this is a

sexual character; otherwise it would be a good structural distinction from *Hybolasius.*

Pœcilippe stictica, n. sp.

P. nigro-fusca, nitida, antennis pedibusque castaneis; thorace sparsim ochreo-pubescente, impunctato, tuberculis discoidalibus tribus parvis; elytris apice obtuse rotundatis, grosse punctatis, punctis versus apicem sparsioribus; griseo maculatim pubescentibus, maculaque tomentosa ochracea reniformi utrinque ad trientem longitudinis ornatis. Long. 4 lin.

Auckland (*Mr. Lawson*); one specimen.

The close grey pubescence of the elytra is divided by the large punctures, producing a spotty appearance; these large punctures are very dense near the base, but become confined to lines posteriorily, leaving smooth spaces, and as such extend to the apex.

Lamia flavipes, White, Voy. Ereb. & Terr., Ins. p. 21.

I have not seen this insect, which, from the description, resembles somewhat the *Pœcilippe* above described.

Diastamerus tomentosus, Redtenb. Reise Novara, Col. p. 177, t.v. f.1.

The intermediate tibiæ are without notch, the claws divaricate, and the pro- and mesosterna broad and plane, with a declivity on their opposing extremities. The genus is very distinct, and approaches the *Hebesecinæ* in its chief characters, with some resemblance to *Ranova* and *Tetradia.* I am indebted for a specimen to Mr. Pascoe.

Tympanopalpus dorsalis, Redtenb. Reise Novara, Col. p. 180, t.v. f.3.

The cicatricized apex of the scape of the antennæ and general form show that this very remarkable genus belongs to the *Monohamminæ,* or some group nearly allied thereto.

Note.—*Dorcadida bilocularis,* mentioned by White as a New Zealand insect, is from Tasmania, and was doubtless introduced by White into the New Zealand fauna by error.

Hesperophanes unicolor (*Saperda unicolor,* Fab. Mant. i. p. 147), cited as from New Zealand in Harold and Gemminger's 'Catalogus,' t. ix. p. 2808, does not belong to that country, being, as Fabricius states, from Amsterdam Island. According to the type still preserved in the Banksian collection, the species belongs to the genus *Ceresium* or *Diatomocephala,* and is distinguished by its clothing of long hairs.

III.—BOTANY.

Art. XLVII.—*On the Flowering Plants and Ferns of the Chatham Islands.*
By John Buchanan, *of the Geological Survey Department.*
Plates XII—XV.

[*Read before the Wellington Philosophical Society, 21st November,* 1874.]

The present list of the Chatham Island plants is compiled from the collection in the herbarium of the Colonial Museum at Wellington. Nearly the whole of this collection has been made by Mr. H. H. Travers in the course of two visits paid to those islands in the years 1866 and 1871. A few specimens have been added to the collection at different times by other parties visiting those islands. With few exceptions all the plants in this list are also common to New Zealand, and will be found described in Hooker's Handbook of the New Zealand Flora, a work which is generally in the hands of every person taking any interest in the subject. Short descriptions will be added of the few not described there.

This list, however, is only published provisionally till Baron F. von Mueller, of Melbourne, who has undertaken the task, finds time from more important labours to furnish a complete analytical list of the whole.

An analysis of the present list shows the total number of plants indigenous to the Chatham Islands of the classes Dicotyledons, Monocotyledons, and Filical Alliance to be 205 species, belonging to 129 genera, and divided among the three classes as follows :—

	Gen.	Sp.
Dicotyledons	72 ...	109
Monocotyledons	37 ...	49
Ferns and Allies	20 ...	47
	129	205

Of this number 191 species are common to New Zealand. One species, *Leucopogon richei*, is also common to Australia, leaving only 13 species peculiar to the Chatham Islands. The latter are marked with a * in the list.

DICOTYLEDONS.

Ranunculaceæ.

Ranunculus plebeius, Br.
rivularis, Banks and Sol.
acaulis, Banks and Sol.

CRUCIFERÆ.

Nasturtium palustre, DC. var. *terrestre*.
Cardamine hirsuta, Linn., var. *a. debilis*.
Lepidium oleraceum, Forst.

VIOLARIEÆ.

Viola cunninghamii, Hook. fil.
Hymenanthera latifolia, Endl. var. *chathamica* (F. v. Mueller, 'Veg. Chatham Islands,' but not described there).

A small pale-barked shrub-tree in bush. Leaves shortly petiolate, oblong ovate, acuminate at both ends, 2—3 inches long, $\frac{3}{4}$—1 inch broad, serrate, strongly reticulated on both surfaces; coriaceous; flowers fascicled on the branches, peduncles decurved, 1-5th inch long, with two minute bracts near the middle, calyx-lobes obtuse, ciliolate, not spreading; petals linear oblong, twice as long as the sepals; anthers erect, connate into a fringed membranous tube. Fruit not seen.

This var. has also been collected by Dr. Hector in the Upper Rangitikei country, with large lanceolate leaves 3—4 inches long, sharply serrate, the venation on both surfaces strongly marked and very coriaceous.

CARYOPHYLLEÆ.

Stellaria parviflora, Banks and Sol.
Colobanthus billardieri, Fenzl.

MALVACEÆ.

Plagianthus divaricatus, Forst.
betulinus, A. Cunn. Nat. name—Houhere. 10—15 feet high.

LINEÆ.

Linum monogynum, Forst.

GERANIACEÆ.

**Geranium traversii*, Hook. fil. (Pl. XIII. f. 2.)

RHAMNEÆ.

Discaria toumatou, Forst.

SAPINDACEÆ.

Dodonæa viscosa, Forst.

ANACARDIACEÆ.

Corynocarpus lævigata, Forst.

CORIARIEÆ.

Coriaria ruscifolia, Linn.

LEGUMINOSÆ.

Sophora tetraptera, Aiton, var. *grandiflora*.

ROSACEÆ.

Potentilla anserina, Linn., var. *b*.
Acæna sanguisorbæ, Vahl.
" " var. *a*.

In addition to the species, which is common both to New Zealand and the Chatham Islands, this well-marked var. has been collected by Mr. H. H. Travers on both visits. Characterised by its larger size, very silky habit, and

MYOSOTIDIUM NOBILE, Hook.

J. Buchanan, del. et lith.

long bristles on the calyx. It is often found among scrub, growing 6—8 feet high ; stems rigid upright.

CRASSULACEÆ.

Tillæa moschata, DC.

DROSERACEÆ.

Drosera binata, Labill.

HALORAGEÆ.

Haloragis alata, Jacq.
Myriophyllum elatinoides, Gaud.
pedunculatum, Hook. fil.
Callitriche verna, Linn.

ONAGRARIEÆ.

Epilobium confertifolium, Hook. fil., var. *a.*
rotundifolium, Forst.
junceum, Forst.
pubens, A. Rich.
billardierianum, Seringe.
pallidiflorum, Sol.

FICOIDEÆ.

Mesembryanthemum australe, Sol.
Tetragonia implexicoma, Miquel, var. *chathamica.*

Widely spreading, or frequently climbing, frutescent leaves broadly rhomboid, occasionally broadly lanceolate, pedicels axillary, solitary, or geminate, downy, longer than the flower, lobes of the calyx unequal in size, semilanceolate, inside intensely yellow, stamens 12—16, styles 3—4, fruit 3—4-celled, spherical, red, 3—4-seeded, without wings or teeth. (F. Muell. *l. c.*)

UMBELLIFERÆ.

Hydrocotyle asiatica, Linn.
moschata, Forst.
Crantzia lineata, Nutt.
Apium australe, Thouars.
Oreomyrrhis colensoi, Hook. fil.
**Aciphylla traversii*, F. Muell. (*Gingidii* sp. F. Muell. *l. c.*; Hook. f. Handb. N.Z. Flora ii. 729).

Plant small, 10in. high, rather flaccid, smooth, leaves all radical, pinnate, 2in. long, numerous, sheath 2in. long, denticulate, $\frac{1}{2}$in. broad, with membranous margins, leaflets 5—7, striate and pungent, scape stout, striate, bearing at top one bract and seven involucral leaves similar to the radical leaves, of 5—7 leaflets, and seven long, peduncled, densely capitate, globular umbels of fruit, peduncles unequal, $1\frac{1}{2}$—2 inches long, grooved, umbels 1in. in diameter, compound, involucral, leaves of fruit, linear, subulate, $\frac{1}{3}$in. long, carpels with five wings, the central dorsal broadest.

Aciphylla lyallii, Hook. fil.
monroi, Hook. fil.

Collected on both visits.

**Ligusticum dieffenbachii*, Hook. fil. (*Gingidium dieffenbachii*, F. Muell. *l. c.* 17).
Daucus brachiatus, Sieb.

Araliaceæ.

Panax crassifolia, Dcne & Planche. (*Hedera crassifolia*, A. Gray ; F. Muell, *l. c.*)

This species, so remarkable in New Zealand for its varied leaf-form, shows in the Chatham Island plant another well marked variety.

In the varieties of New Zealand the leaves, whether one or three foliolate, are much elongated, narrow, and reflexed downwards for several years before flowering ; afterwards they become shorter, broader, and erect.

In the variety under notice the leaves are erect from the first, before flowering being 3—10 inches long, 1—1½ inches broad, and with a few deep serrations at the tips. Mixed with these in the earliest stage are a few small obcordate leaves, 1in. long, ¾in. broad. After the plant commences to flower, the leaves diminish in size and become entire. The fruit is more elongate in this variety than in the varieties of New Zealand, resembling most that of *Panax lineare*, Hook. fil., from Dusky Bay, South Island.

Corneæ.

Corokia buddleoides, A. Cunn.

Native names—*Whakataka* and *Hokataka* ; grows 15—20 feet high.

Rubiaceæ.

Coprosma baueriana, Endl.

Nat. name—*Karamu*. This species is found in the bush as a small tree, 10—12 feet high.

Coprosma robusta, Raoul.
cunninghamii, Hook. fil.
propinqua, A. Cunn.

Nat. name—*Mingimingi* ; 3—6 feet high, according to Mr. Travers, forming a considerable portion of the bush, and from its dense close growth almost impenetrable.

Coprosma acerosa, A. Cunn.

Compositæ.

Olearia angustifolia, Hook. fil., var. (*Olearia operina*, Hook f. *l. c.* 731 ; *Eurybia operina*, Forst. F. Muell. *l.c.*)

Leaves very variable in size, obovate-acute to ovate-obtuse, 1—3 inches long, ½—1 inch broad, very coriaceous. Peduncles none or short, with a few lax bracts. Flowers large, purple ; single flowering, in succession over a lengthened period. Achenes ribbed, silky. Pappus robust ; purple on the upper half, pale yellow on the lower. More closely allied to *O. angustifolia* than to *O. operina*.

**Olearia semidentata*, Decaisne, (Pl. XIV).

Described by Mr. H. H. Travers as a beautiful shrub 1—3 feet high, having masses of dark purple flowers, and generally growing in damp places. The leaves of young plants are very close set and narrow, differing in this

1. VERONICA CHATHAMICA. n.s.
2. GERANIUM TRAVERSII. Hook. fil.

J. Buchanan, del. et lith.

OLEARIA SEMIDENTATA, Decaisne.

J. Buchanan, del. et lith.

respect from young plants of *O. operina* and *O. angustifolia*, to both of which it is allied.

**Olearia traversii*, F. Muell.

Nat. name—*Akeake*; 20—30 feet high, and sometimes 2 feet in diameter. This may be considered as the only valuable timber tree in the islands, being durable and not subject to the attacks of insects.

Brachycome sinclairi, Hook. fil.
Cotula coronopifolia, Linn.
  *(*Myriogyne*) *featherstonii*, F. Muell.
  lanata, Hook. fil.
Craspedia fimbriata, DC.
Gnaphalium bellidioides, Hook. fil.
  filicaule, Hook. fil.
  luteo-album, Linn.
  involucratum, Forst.
  collinum, Labill.
Erechtites prenanthoides, DC.
  scaberula, Hook. fil.
  quadridentatus, DC.
Senecio lautus, Forst.
  „ Forst., var. *radiolatus* (*S. radiolatus*, F. Muell., *l. c.*).

A broader leaved var. of this species than that from the Chatham Islands has since been collected by Mr. Travers on the Brothers Rocks, Cook Strait. The leaves are remarkably thick and fleshy, and only show membranous, as stated in the Handb. N.Z. Flora, p. 734, after drying.

**Senecio huntii*, F. Muell. Nat. name—*Rautine*. (F. Muell., *l. c.*)
Taraxacum dens-leonis, Desf.
Sonchus oleraceus, Linn.
Wahlenbergia gracilis, A.DC.
Lobelia anceps, Thunb.
Pratia macrodon, Hook. fil.

ERICEÆ.

**Cyathodes robusta*, Hook. fil. (*C. acerosa*, Br., var. *b. latifolia*, Flora N.Z. i., 163, and Veg. Chatham Islands, 43).
Leucopogon richei, Br. (F. Muell., *l. c.* 45).
Pentachondra pumila, Br.
Dracophyllum scoparium, Hook. fil., Flora Antarct. i. 47 (*D. urvilleanum*, A. Rich, var. *d.* Handb. N.Z. Fl. i. 182; *D. latifolium*, Hook. fil., var. *ciliolatum*, *l. c.* ii. 736).

A small tree 20—30 feet high. Specimens in Mr. Travers' collection show the young leaves flat, 8—9 inches long, and ¾ inch broad, becoming reduced in size before flowering to 2—3 inches long, very narrow, involute, and ciliate on the lower margin in all stages; both sizes may be found on the same plant, the larger form on the lower branches only.

In the young state the fascicles of large broad leaves bear a considerable resemblance to those of *D. latifolium*, A. Cunn., and *D. menziesii*, Hook. fil., neither of which are found on the islands.

This plant, from its large leaves when young and ciliate margins, has good claim to be re-established as a distinct species, though latterly it has only been considered as a var. of *D. urvilleanum.*

It is also found in the Lake District of Otago, where it was at first supposed to be *D. menziesii*, Hook. fil., never having been found in flower, although the leaf transition was noticed on small plants.

Dracophyllum rosmarinifolium, Forst.

A small shrub 3—8 inches high. In Mr. Travers' collection rooted specimens 3—4 inches high are found in flower. It agrees in every respect with the above species, except in sometimes having 1—4-flowered spikes, instead of 1—2-flowered spikes, as described by Dr. Hooker (Handb. N.Z. Flora, 183).

MYRSINEÆ.

**Myrsine chathamica*, F. Muell.

Shrubby, erect, much branched. Leaves $1\frac{1}{2}$—$2\frac{1}{2}$ inches long, obovate-oblong, obtuse or emarginate, pale and reticulated on both surfaces (Dr. Hooker, Handb. N.Z. Fl. 736). The fruit is described by Baron F. von Mueller as purplish, spherical, one-seeded, size of a large pea. To this may be added: Flowers in capitate lateral fascicles; calyx, 4-lobed; petals, 4, pale greenish, spotted red, ciliate on the margins, erect; stamens, 4, adherent to the petals; anthers large; stigma sessile, capitate. Dr. Hooker thinks this may be a large state of *M. urvillei*, and specimens of the latter, with large, nearly flat leaves, found in New Zealand, approach it very closely, except in size of fruit.

Myrsine nummularia, Hook. fil.

PRIMULACEÆ.

Samolus littoralis, Br.

GENTIANEÆ.

Gentiana pleurogynoides, Griseb.

BORAGINEÆ.

**Myosotidium nobile*, Hook. (Pl. XII.)

CONVOLVULACEÆ.

Convolvulus sepium, Linn.
soldanella, Linn.
Dichondra repens, Forst.

SOLANEÆ.

Solanum aviculare, Forst.
nigrum, Linn.

SCROPHULARINEÆ.

Veronica salicifolia, Forst. (*V. forsteri*, F. Muell. var. *salicifolia*, *l. c.* 46.)
**dieffenbachii*, Benth.
**chathamica*, n. sp. (*V. forsteri*, F. Muell. var. *elliptica*, *l. c.* 46.) Pl. XIII. f. 1.

A small prostrate rambling shrub. Branches wiry, $\frac{1}{8}$ inch diameter, pubescent. Leaves spreading, irregular in size, sessile, $\frac{1}{3}$—$1\frac{1}{2}$ inches long, 1-5th—$\frac{1}{2}$ inch broad, obovate-oblong or ovate-oblong, acuminate, entire, flat, scarcely coriaceous. Racemes few or many, 1—$1\frac{1}{2}$ inches long, subterminal at the ends of the branches and axillary to the uppermost leaves, orbicular or ovate. Flowers numerous, closely set; peduncles $\frac{1}{2}$ inch long, pubescent; pedicels and lanceolate bracts equal in length, pubescent; sepals $\frac{1}{8}$—$\frac{1}{6}$ inch long, linear lanceolate, ciliate; corolla large, dark purple, tube short; capsule imperfect. This beautiful shrub has been cultivated by Mr. Travers in his garden in Wellington, where the profusion of its dark purple flowers and prostrate habit has proved a most showy addition to those plants adapted for the ornamentation of rock-work or earth banks.

VERBENACEÆ.

Myoporum lætum, Forst.

LABIATA.

Mentha cunninghamii, Benth.

CHENOPODIACEÆ.

Chenopodium triandrum, Forst.
glaucum, Linn.
Atriplex patula, Linn.
billardieri, Hook fil.
Salicornia indica, Willd.

POLYGONEÆ.

Polygonum minus, Huds., var. *decipiens.*
Muhlenbeckia adpressa, Lab.

THYMELEÆ.

Pimelea arenaria, A. Cunn.

EUPHORBIACEÆ.

Euphorbia glauca, Forst.

URTICACEÆ.

Urtica australis, Hook fil.
Parietaria debilis, Forst.

PIPERACEÆ.

Piper excelsum, Forst.

MONOCOTYLEDONS.

ORCHIDACEÆ.

Earina mucronata, Lindl.
Acianthus sinclairii, Hook. fil.
Corysanthes macrantha, Hook. fil.
Microtis porrifolia, Spreng.
Pterostylis banksii, Br.
banksii, Br., var. *b.*
micromega, Hook. fil.
Caladenia bifolia, Hook. fil. (*Chiloglottis traversii*, F. Muell., *l. c.*, 51.)
Chiloglottis cornuta, Hook. fil.
Thelymitra longifolia, Forst.

IRIDEÆ.

Libertia ixioides, Spreng.

NAIADEÆ.

Triglochin triandrum, Mich.
Potamogeton natans, Linn.
Ruppia maritima, Linn.

LILIACEÆ.

Rhipogonum scandens, Forst.
Astelia cunninghamii, Hook. fil.
grandis, Hook. fil. (Trans. N.Z. Inst., IV., 245, Mr. Kirk on N.Z. Asteliads).
Phormium tenax, Forst.

PALMEÆ.

Areca sapida, Sol.

JUNCEÆ.

Juncus planifolius, Br.
bufonius, Linn.
novæ-zealandiæ, Hook. fil.
Luzula campestris, DC.

RESTIACEÆ.

Leptocarpus simplex, A. Rich.
**Sporadanthus traversii*, F. Muell., n. gen. and n. sp.

CYPERACEÆ.

Schœnus axillaris, Hook. fil.
Scirpus triqueter, Linn.
Eleocharis gracilis, Br., var. *c. radicans.*
acuta, Br., var. *platylepis.*
Isolepis nodosa, Br.
aucklandica, Hook. fil.
Desmoschœnus spiralis, Hook. fil.
Cladium glomeratum, Br.
Uncinia rupestris, Raoul.
Carex appressa, Br.
forsteri, Wahl.
trifida, Cavan.
lambertiana, Boott.

GRAMINEÆ.

Hierochloe redolens, Br.
Dichelachne crinita, Hook. fil.
Agrostis æmula, Br.
Arundo conspicua, Forst.
Danthonia semi-annularis, Br.
Deschampsia cæspitosa, Palisot.
Trisetum subspicatum, Palisot.
Poa breviglumis, Hook. fil.
foliosa, Hook. fil., var. *a.*
" " var. *b.*
Festuca littoralis, Br.

CRYPTOGAMIA.

FILICES.

Gleichenia dicarpa, Br.

OLEARIA ANGUSTIFOLIA, Hook. fil. *var.*

J. Buchanan del. et lith.

Cyathea dealbata, Swartz.
medullaris, Swartz.
Dicksonia squarrosa, Swartz.
Hymenophyllum bivalve, Swartz.
dilatatum, Swartz.
javanicum, Spreng. (*H. crispatum*, Wallich, Synopsis Filicum.)
demissum, Swartz.
flabellatum, Labill.
Trichomanes reniforme, Forst.
venosum, Br.
Lindsaya linearis, Swartz.
Adiantum hispidulum, Swartz.
affine, Willd. (*A. cunninghamii*, Hook. fil., Synopsis Filicum.)
Hypolepis tenuifolia, Bernh.
distans, Hook.
Pellæa rotundifolia, Forst.
Pteris aquilina, Linn., var. *esculenta*.
scaberula, A. Rich.
incisa, Thunb.
Lomaria procera, Spreng., var. *d*.
dura, Moore.
lanceolata, Spreng.
discolor, Willd.
alpina, Spreng.
Asplenium obtusatum, Forst.
var. *g*. *lucidum*.
var. *g*. *lyallii*.
falcatum, Lam.
bulbiferum, Forst.
flaccidum, Forst., var. *d*.
Aspidium aculeatum, Swartz.
oculatum, Hook.
capense, Willd. (*A. coriaceum*, Swartz, Synopsis Filicum).
Nephrodium decompositum, R. Br., var. *b*.
Polypodium grammitides, Br.
punctatum, Thunb., var. *b*. (*P. rugulosum*, Labill., Synopsis Filicum).
pennigerum, Forst.
serpens, Forst. (*P. rupestre*, R. Br., Synopsis Filicum).
pustulatum, Forst.
billardieri, Br.
Schizæa fistulosa, Labill.
Ophioglossum vulgatum, Linn., var. *b*. *costatum*.
Botrychium ternatum, Swartz, var. *dissectum* (*B. cicutarium*, Sw., Synopsis Filicum.

LYCOPODIACEÆ.

Lycopodium varium, Br.
billardieri, Spreng.
densum, Labill.
laterale, Br.
scariosum, Forst.
volubile, Forst.
Tmesipteris forsteri, Endl.

Art. XLVIII.—*Observations on the different Modifications in the Capsules of Mosses, with reference to the Dispersion of their Spores.*

By Captain F. W. Hutton, C.M.Z.S., etc.

Plate XXII.

[*Read before the Otago Institute, 12th October,* 1874.]

The fructification of mosses consists of a variously shaped capsule, or sporangium, generally placed on a stalk, which is sometimes short, but generally much elongated (Plate XXII., fig. 13). Through the centre of the capsule rises a pillar of cellular tissue called the columella (fig. 15), and it is round the columella, between it and the wall of the capsule, that the spores, or seeds, are formed.

It is evident that if these spores were liable to be all blown away together by the first puff of wind that occurred after they were ripe, or to be all knocked out by the first drop of rain that fell upon the capsule, they would have but little chance of being widely dispersed. If also the spores escaped and were blown away in moist weather they could not travel far, for they would stick to the first leaf or stone that they were blown against. If, on the other hand, there were some means of holding the spores fast in wet weather, and letting them escape when the air was dry, and then only by a few at a time, so that some might be driven off in one direction, some in another, it is evident that they would then be scattered as far and as wide as possible.

But as mosses inhabit very different stations, some living among long grass or in swamps, others on exposed walls; some on trees, others under water; some in sheltered ditches, and others on mountain peaks, different combinations will be required by different species. For example, those species that grow among long grass require a long fruit-stalk to elevate the capsule above the grass and so let it be exposed to the wind; while this would be detrimental to those mosses that live in exposed situations, and these generally have the fruit-stalk so reduced in length that the capsule is buried in and protected by the perichætial leaves, unless the species possesses some other and more perfect way of preventing its spores being blown away; and I propose to offer a few observations on the different approaches towards perfection in attaining this object that are found in various genera and species of mosses.

I have already said that the spores are contained in a capsule placed on the top of a fruit-stalk. In by far the larger number of mosses this capsule is furnished with a lid, or operculum (fig. 14), which falls off when the spores are ripe, and the mouth of the capsule is then seen to be either naked (fig. 1), or furnished with numerous teeth and cilia, called the peristome (fig. 14). The

fruit-stalk is sometimes straight, but often curved, so that the capsule is inclined or pendulous (fig. 13), with the mouth turned downward and thus protected from rain. In some mosses the same effect is obtained by the capsule itself being cernuous, while the fruit-stalk is straight.

In order to give some method to the remarks that follow I shall divide the mosses into (1) those in which the capsule alone is used; (2) those in which the peristome is used; and (3) those in which the columella is used, combined either with the operculum or with the peristome.

1. *Mosses in which the capsule alone is used.*

In the lowest forms, the family Phascei, the capsule decays and bursts open irregularly so that the spores are quite exposed, except in those species where the capsule is immersed in the perichætial leaves. But it must be remarked that in *Phascum cuspidatum*, which is the only species in which I have been able to make the observation, the perichætial leaves open when wet and close when dry, so that the protection thus afforded can be but slight. They have, however, very few spores in a capsule, *Phascum alternifolium* only having about sixteen, and *P. serratum* about one hundred, so that it would hardly be necessary to protect so few from being all blown away together. These mosses are all inhabitants of the plains, and grow on ditch banks and other sheltered situations; but there is another family, the *Andreæeæ*, which lives on exposed rocks on mountains, and yet has the capsule not much more complicated than in the humble Phascei. In this family when the spores are ripe the capsule divides longitudinally into four or more parts, the upper extremities of which adhere together. These parts bend downward when dry, and allow the spores to escape through the open fissures (fig. 8*b*), but on the air getting damp they straighten and close up the capsule again quite tight (fig. 8*a*), and thus prevent the spores being blown away in wet weather.

The first step towards a more complicated state of things is when the capsule, instead of bursting through decay, is furnished with an operculum, which falls off when the spores are ripe, thus leaving them to some extent protected by the vase-like form of the capsule. Some genera of mosses, such as *Braunia*, *Physcomitrium*, and *Aulacopilum*, have no further provision against all their spores being knocked out at once; but in others, as *Hedwigia* and *Leptangium*,* the capsule is immersed in the leaves. In the genus *Sphagnum*, when the capsule is ripe, the operculum and spores are said to be driven off with violence to a distance of six or seven inches. The next step is the formation of a flexible ring of very hygroscopic cells, called the annulus (fig. 14), interposed between the mouth of the capsule and the operculum, as in *Œnectangium* and *Calomnion*, which protects in some measure the spores from

* *Leptangium* is said by Dr. Hooker to have the mouth of the capsule closed in by a membrane. I have had no opportunity of examining it personally.

the wind; while in some species of *Gymnostomum*, as well as in *Calomnion*, a further provision is made by the walls of the capsule being much thickened at the mouth, which reduces the size of the opening. In most of those genera in which the apparatus for protecting the spores is more perfect this annulus falls away* after it has performed its office of throwing off the operculum from the capsule, but in the genera just mentioned it is persistent.†

In *Œnectangium* also the spores are very minute and numerous, which gives evident facilities for their far and wide dispersion‡

2. *Mosses in which the peristome is used.*

I come now to that large division of mosses which have a series of teeth, called the peristome, arranged round the mouth of the capsule. In its most complete state this peristome consists of an external row of sixteen conical teeth, and an internal folded membrane divided above into processes sometimes with cilia between each (fig. 7). The inner peristome is, however, variously modified, and is often altogether absent. The outer peristome consists normally of sixteen teeth, which are sometimes split half way down, as in *Dicranum*, *Fissidens*, etc. Sometimes they are divided to the base so as to make their number thirty-two, as in *Trichostomum* and *Tortula*. In rare cases also two teeth are joined together so as to reduce their number to eight, as in the tropical genus *Octoblepharum*, while occasionally they are reduced to four, as in *Tetraphis*.

The peristome also is very variously developed in different mosses. In some, such as *Weissia*, *Didymodon*, *Conomitrium*, etc., the teeth are short and fragile and soon break off. In *Trichostomum*, *Encalypta*, etc., they are stronger; while in most genera they are strong and answer admirably their purpose of preventing the too easy escape of the spores.

These mosses can be divided into five groups in each of which the peristome is used in a different way.

(*a*.) The first group, which is represented in New Zealand by the genera *Dicranum*, *Dicranodontium*, *Campylopus*, *Racomitrium*,|| *Leucobryum*, *Grimmia*, *Ceratodon*, *Conostomum*, and *Symblepharis*, have the peristome long and well formed, and the teeth stand nearly erect round the mouth of the capsule with

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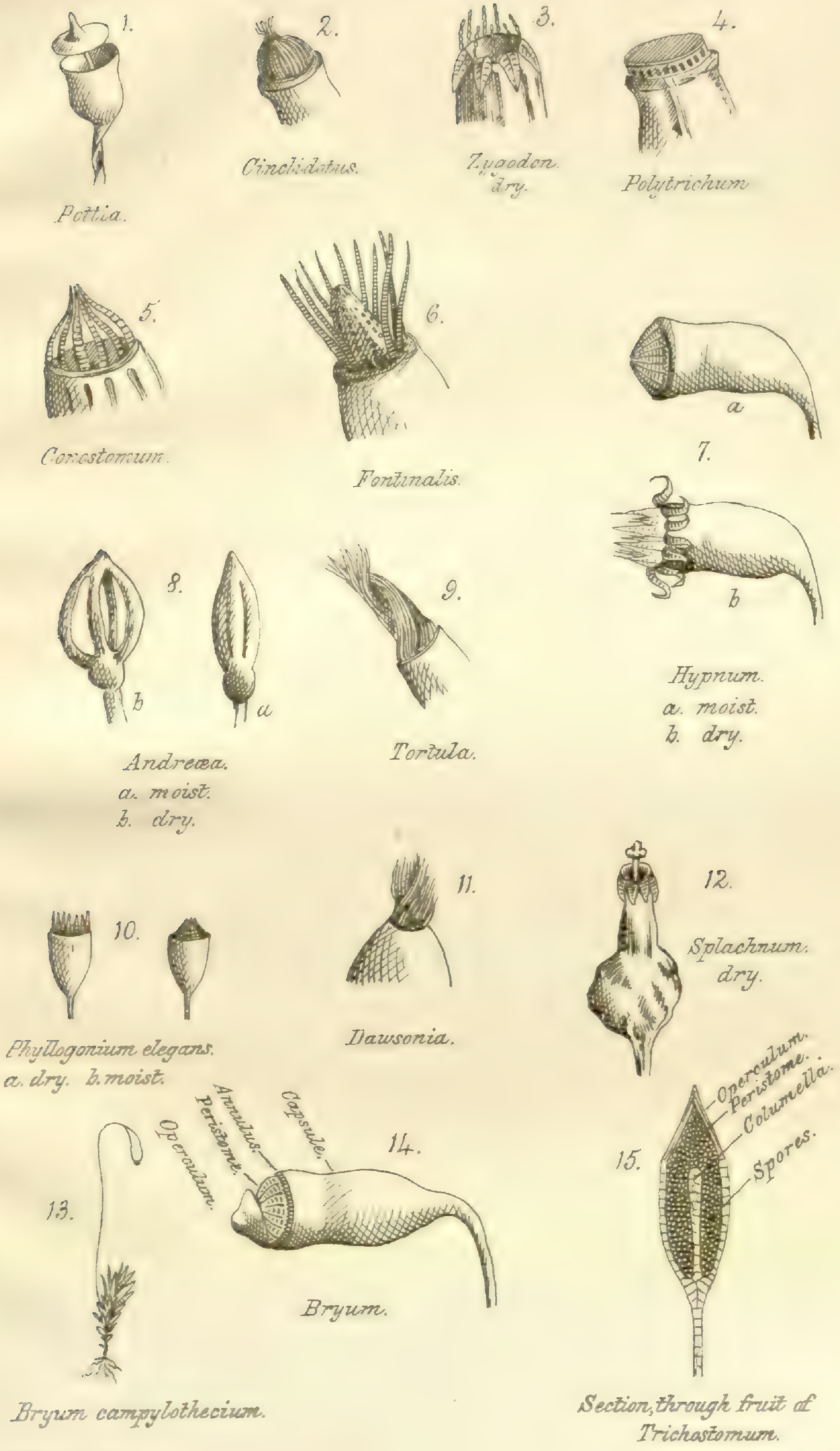
* *Symblepharis* is an exception.

† *Brachyodus* might be placed here, for its peristome being shorter than the annulus, it cannot in any way affect the dispersion of the spores.

‡ I have not, however, been able to trace any connection between the abundance or rarity of a moss and the size of its spores. For instance, the spores of *Hypnum cupressiforme* and *H. rutabulum* are nearly twice the diameter of those of *H. prælongum* and *H. confertum*, while *H. triquetrum* and *H. purum* hold an intermediate position.

|| In *Racomitrium aciculare* the teeth are slightly hygroscopic, spreading when dry, but erect and slightly incurved when wet. I have noticed that in species a sticky substance is found amongst the spores, which is drawn out into lines like cobwebs between the teeth, and by this means the spores are often stuck on to the inner side of the peristome.



F. W. Hutton, del.

their points touching or interlaced, so as to form a kind of cage over the mouth which protects the spores from the wind, but allows them to be blown away in small quantities at a time, and by high winds only. In *Conostomum* (fig. 5), which inhabits exposed rocks on mountains, this cage is further strengthened by the tips of the teeth cohering together, and this moss may be said to be the type of the group. All these mosses have strong persistent peristomes well calculated to resist the wind, consequently we find that many of them inhabit mountains or subalpine regions, and several grow upon exposed rocks, while in some species of *Grimmia* only is the capsule immersed in the perichætial leaves. The peristome however is not able to protect the spores from the wet, and to accomplish this the greater part have the mouth of the capsule inclined or bent downwards either through the fruit-stalk being curved, or the capsule being cernuous or drooping. I must here remark that the fruit-stalk of *Campylopus* is hygroscopic, being curved and burying the capsule among the leaves in dry weather, while when the air is moist standing more erect, an anomaly for which I can offer no explanation. In *Seligeria recurvata* the fruit-stalk straightens when dry.

(*b*.) In the second group, which is represented in New Zealand by *Dawsonia superba* and the genera *Trichostomum* and *Tortula*, the peristome consists of numerous filiform, slightly hygroscopic teeth, which are either distinct from one another, or united at the base into a membrane. In *Trichostomum* and *Dawsonia superba* (fig. 11) the teeth are nearly straight, but in *Tortula* (fig. 9) they are twisted into a spiral, which in damp weather twists tighter and closer over the mouth of the capsule. The mosses in this group are preeminently inhabitants of the plains, their peristome being too weak and fugacious to withstand the boisterous winds of the mountains. *Tortula* possesses the strongest peristome, and consequently we often find it growing on walls and other exposed places, while *Trichostomum* and *Didymodon* generally grow on the ground or in sheltered hollows. All have the fruit-stalk elongated, and the capsule erect or nearly so.

(*c*.) In the third group the teeth are all more or less hygroscopic, opening when dry and closing over the mouth of the capsule when wet. In some, *e.g.*, *Phyllogonium* (fig. 10) and *Blindia*, the movement is small and the teeth when wet never get beyond an erect position; in others, *e.g.*, *Fissidens* and *Cryphæa*, they continue the movement until they have attained a horizontal position, and then curl their points inward; in others again, such as *Orthotrichum*, *Zygodon* (fig. 3), *Eremodon* and *Fabronia*, the movement is still further continued until their backs are adpressed against the outer sides of the capsule. In this group the peristome is beautifully adapted for preventing the spores being dispersed in wet weather, but there is nothing to prevent them being all blown away in one direction by the first strong wind, and we find therefore that they are chiefly inhabitants of the plains, and generally

grow in forests and sheltered places. With the exception of some species of *Orthotrichum* the capsule is always exserted, and in *Macromitrium* it is sometimes much elongated. *Fissidens* is the only genus with the mouth of the capsule inclined or directed downward.

(*d.*) In the fourth group the peristome is double, the inner one being composed of a membrane more or less divided in the upper part. The outer peristome is hygroscopic, closing tight over the mouth of the capsule when moist, and spreading outward with the tips of the teeth incurved when dry. The inner peristome is not hygroscopic, but on the opening of the outer peristome the interior projections, or "trabeculæ", as well as the points of the teeth, get entangled in the perforations and cilia of the inner peristome and drag it open, often quitting their hold with a jerk which spirts out the spores to some little distance, thus answering the same purpose as the elaters of the *Hepaticæ*. This group is a very large one and includes the New Zealand genera of *Bryum*, *Cladomnion*, *Isothecium*, *Hypnum* (fig. 7), *Rhizogonium*, *Hypopterygium*, *Racopilum*, *Hookeria*, and others. These mosses are chiefly inhabitants of plains and forests; in nearly all the species the capsule is inclined, while in some, *e.g.*, *Bryum* and *Mnium*, it is pendulous (fig. 13), so that its mouth is directed straight downward. All have the fruit-stalk elongated except *Fontinalis*, a northern genus that lives in water. In this moss (fig. 6) the outer peristome is hygroscopic, and the inner is converted into a conical membrane regularly perforated with square holes, which prevents the spores being washed ont too quickly.

(*e.*) The fifth group consists of the genus *Funaria* alone, which stands apart from all other mosses as far as the apparatus for the dispersion of the spores is concerned. In this moss the peristome is double, the points of the teeth of the outer one being connected by a disc, which in time falls away. The inner consists of narrow teeth, which might almost be called cilia. Both are hygroscopic, and curl outward when dry after the rupture of the disc. The capsule also is pendulous on a hygroscopic fruit-stalk, which, however, when either curling or uncurling, always keeps the mouth of the capsule directed downwards, and thus protects it from the rain. We thus see that this moss combines the advantages of the first and third groups. At first its strong united peristome enables it to distribute its spores in small quantities to high winds only, while afterwards the mouth of the capsule opens wide, and allows, on the first dry day, all those spores that still remain to be blown away, and so prevents them from being wasted through failing to escape from the capsule. This is perhaps the most perfect apparatus possessed by any moss, and we cannot wonder at its almost cosmopolitan distribution.

3. *Mosses in which the columella is used.*

These mosses may be divided into two groups, which use the columella in connection with the operculum or the peristome respectively.

(*a.*) In some European mosses, such as *Gymnostomum curvirostrum*, *Pottia truncata* (fig. 1), *P. heimii*, and *Stylostegium cæspiticum*, the operculum adheres to the columella, which elongates when the spores are ripe and lifts up the operculum. Some mosses even which have peristomes have also the operculum adhering to the columella, such as *Dissodon hornschuchii*, from Europe and North America; and in *Climacium dendroides*, also from Europe, the operculum is lifted up in dry weather, but when the air is moist the columella contracts again and closes up the mouth of the capsule.

(*b.*) In the European genus *Cinclidotus* (fig. 2), which lives in water, the columella is exserted and the filiform teeth of the peristome are twisted round it, thus forming a cage as in *Fontinalis*, but on quite a different principle. When the capsule gets dry or old the columella shrinks and breaks off the upper part of the peristome, thus liberating those spores that had previously failed to make their escape.

In *Splachnum* (fig. 12) the columella is large, exserted, and dilated at the top. In moist weather the teeth fold over the mouth of the capsule and touch the dilated apex of the columella, but in dry weather they bend back until they are adpressed against the outer side of the capsule.

In our species of *Dawsonia* the filaments are, as I have said, free, but in some Australian species these filaments, or cilia, are connected with the top of the columella. In *Wardia*, from the Cape of Good Hope, the peristome consists of an irregularly fissured membrane which adheres to the top of the columella, and *Scouleria*, from North America, has thirty-two laciniated teeth which are also connected with a process on the top of the columella, (Berkely).

But it is in the *Polytrichaceæ* that the columella is put to the greatest use for protecting the spores. In the genus *Polytrichum* (fig. 4) the top of the columella is spread out into a thin flat drum-like membrane that extends over the whole orifice of the capsule, and is connected at its edge with the mouth of the capsule by thirty-two or sixty-four short processes formed of many threads, like those in *Dawsonia*, soldered together, so that the spores can only escape through the apertures between these processes, and consequently only a few are likely to be blown out at a time. The genus *Lyallia*, from India, has a similar membrane over the mouth of the capsule, but at length the columella contracts within the capsule, and detaches a circular portion from the centre of the drum, thus releasing those spores which have failed to make their escape. As this membrane extends over the whole of the mouth of the capsule, it entirely excludes the rain when the capsule is erect, which position is therefore in this case better than an inclined one, and is that which nearly every species of the family assumes. The species are equally distributed between the plains and the mountains.

Art. XLIX.—*Description of a new Species of* Senecio.

By Thomas F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 29th June,* 1874.]

In the spring of 1868, while journeying up the course of the Kaueranga River, at the Thames Gold-fields, I observed in several localities a white-rayed *Senecio*, evidently differing in a marked degree from any known species. Unfortunately, the specimens collected on this occasion were accidentally lost before I had an opportunity of carefully examining them; and although I revisited the locality in 1870, it was at too advanced a period of the year to procure flowers. Last year, however, I was fortunate enough to again find the plant, not only in the district where I originally discovered it, but also in other portions of the gold-field. It may thus be described:—

Senecio myrianthos, n. sp. A slender sparingly branched shrub or small tree, with purplish black bark. Young leaves and branches covered with a thin buff tomentum. Leaves four to five inches long, membranous, ovate or ovate-lanceolate, acute or acuminate, generally unequal at the base, sharply and coarsely doubly serrate, when adult glabrous above, but covered beneath with a thin silvery-white closely appressed tomentum. Primary veins few, conspicuous on both surfaces, forming large areoles. Petioles one to two inches long. Panicles terminal, leafy, large, often over two feet long, but narrow for the length; peduncles and pedicels slender, with a short and thick covering of purplish brown glandular hairs. Ultimate bracts narrow subulate, or almost filiform. Heads numerous, campanulate, $\frac{1}{3}$ inch long. Scales of the involucre about eight, scarious, linear obtuse, glabrous or nearly so. Ray florets four to six, ligules broad, very short, not $\frac{1}{8}$ of an inch, white; disc florets about the same number, campanulate above the middle, five-toothed. Stigmas exserted; anthers slightly tailed. Pappus hairs in a single series, white, prominently denticulate, slightly thickened at the apex. Ripe achenia not seen.

Habitat.—Kaueranga River, Karaka, Tararu, and Puru Creeks; and other localities at the Thames. It is probably not uncommon throughout the Cape Colville peninsula.

A most charming plant, covered when in bloom with large panicles of deliciously sweet-scented white flowers. From the other species of *Senecio*, native to New Zealand, it can easily be distinguished by the slender habit; thin, membranous leaves; the peculiar indumentum on the branches of the inflorescence; the scarious, nearly glabrous scales of the involucre; and the short ligules to the ray florets. The beauty of the flowers will doubtless obtain it a place in both Colonial and European gardens.

ART. L.—*On the Fertilisation of* Acianthus *and* Cyrtostilis.

By THOMAS F. CHEESEMAN, F.L.S.

[*Read before the Auckland Institute, 1st June*, 1874.]

1. *Acianthus sinclairii.*

IN examining the fertilisation of this plant, we do not find contrivances so remarkable and unique as those that obtain in *Pterostylis*, or in other of the New Zealand Orchids; on the contrary, the mode employed is simple, and presents few features of interest. Yet, if the completeness of any method of fertilisation is to be judged of by the results obtained, as undoubtedly it should be, we must regard that of *Acianthus* as one of the most perfect of the many different modes in use among our Orchids.

The flowers, varying in number from one to twelve, are minute, and of an inconspicuous appearance. The lip, which is horizontally spread out in front of the flower, or slightly deflexed, is ovate-lanceolate in outline, and greatly concave, so as to form a kind of bucket. At its base it is furnished with two large glands, and the margins and point are also plentifully studded with minute fleshy papillæ. The column is somewhat curiously shaped. At first it is erect, but towards the summit suddenly arches over the lip, and is much thickened and expanded. The anther is terminal, two-celled, each cell possessing two pollinia, which are deeply bilobed, so as to resemble a horse shoe in shape. The stigma is a deep circular hollow situated just below the anther; and, by the arching of the upper part of the column, hangs directly over the lip. The rostellum is placed on its upper margin. It consists of two triangular projections, which at first are cellular, but ultimately resolve into masses of viscid matter, covered with an extremely delicate membrane. As the flower expands, the connection of these projections with the rest of the column becomes very slender, so that at last they can be detached by a comparatively slight touch, leaving the upper margin of the stigmatic chamber quite plane.

Long before the flower opens, each lobe of the anther splits gradually from base to apex, allowing the included pollinia almost to touch the upper part of the rostellate points. The pollinia then emit a number of excessively delicate thread-like projections, which reach the rostellum, and become firmly attached to it. So that, in a fully expanded flower, each set of pollen-masses is quite free from its anther cells, but they are firmly attached by their bases to their respective rostella, neither of which can be removed without bringing away the pollinia.

The glands at the base of the lip secrete nectar, which is stored up in the cavity just in front of them. From this circumstance alone we might surmise

that the flowers would be frequently visited by insects, and a little observation soon shows this to be a fact. On a warm sunny day it is almost impossible to watch a bed of this Orchid for any length of time without seeing numerous Diptera flitting from flower to flower, busily engaged in robbing them of their sweets.

If we now call to mind the manner in which the column arches over the lip, we can easily see that an insect crawling into the flower to get at the supply of nectar can hardly avoid touching one of the points of the rostellum, ranging almost directly over it; if it did so, the delicate exterior membrane would be at once ruptured, and the viscid mass firmly glued to the insect's back. Thus, on withdrawing from the flower, the visitor would carry away with it not only the portion of the rostellum which it had touched, but also the attached pair of pollinia. These (from each pollinium being nearly subdivided into two) would form four little projections standing rigidly erect on the back of the insect; and consequently, when conveyed to another flower, can hardly fail to strike the overhanging stigmatic chamber, which is sufficiently viscid to detach a portion, at least, of the pollinia from the body of the insect, thus ensuring the fertilisation of the flower.

As I have several times seen insects remove the pollinia, and on one occasion also seen a pollen-mass left on the stigma, there can be little doubt that fertilisation is conducted on this plan. That insect aid is absolutely required is proved by the fact that the pollinia remain in their cells, and never reach the stigma, when the plant is covered up or allowed to expand its flowers in a room. But, under natural conditions, the flowers are so frequently visited that the pollinia are generally removed directly after the opening of the blossoms; while the large proportion of capsules produced is good evidence of the completeness with which the visitors perform their duties. Out of eighty-seven flowers, borne on fourteen plants, no less than seventy-one matured capsules, and of those that had failed to do so, many were imperfect ones situated at the summit of the panicle, and probably incapable of producing seed. Another set, from a different locality, had borne forty-seven flowers, of which no less than forty-four had ripened capsules.

The fact that almost every perfect flower produces a capsule, is in remarkable contrast to what occurs in several other genera of our Orchids. For instance, *Pterostylis* is fertilised on a plan much more complex, and the co-adaptation of the various parts of the flower is so complete that almost every insect that fairly enters the flower must remove the pollinia, which is not the case in *Acianthus.* Yet, from some reason, probably from the want of sufficient attraction, the flowers are comparatively seldom visited, and consequently few capsules produced. In my account of the fertilisation of this genus, (Transactions of the N. Z. Institute, Vol. V, p. 356.) I have

estimated that about one quarter of the flowers produce capsules; but from subsequent observations I am now convinced that the number is much less. *Corysanthes* offers a case of imperfect fertilisation even more singular. In all the species the proportion of capsules produced is very small, and large patches can often be found that have failed to mature a single one. As an illustration, a bed of *Corysanthes triloba*, in a favourable situation for the visits of insects, expanded, during the last season, over two hundred flowers: yet of this large number only five succeeded in ripening capsules. We must be cautious, though, in assuming that the imperfect fertilisation of these plants is of much real disadvantage to them. In many districts *Pterostylis trullifolia* is quite as abundant as *Acianthus*; while the less general distribution of the species of *Corysanthes* is probably due to their organization not being so well adapted to a variety of conditions and habitats, rather than to the scarcity of seed produced. In their special localities they are often abundant.

2. *Cyrtostylis oblonga.*

The great resemblance that this plant bears to *Acianthus*, induced me to suppose that its fertilisation would be conducted on the same plan, and this appears to be the case. We find in *Cyrtostylis*, as in *Acianthus*, the lip horizontally spread out, secreting abundance of nectar; the column arching over it; the points of the rostellum hanging downwards, with the pollinia firmly fastened to their upper margins; together with other contrivances, all apparently co-ordinated, so that an insect, having once entered the flower, can hardly avoid attaching itself to the pollen-masses, and removing them on its departure.

On comparing the flowers of the two plants, we at once find a difference in the structure of the lip. In *Acianthus* this organ is concave, for the purpose of storing up nectar to serve as an attraction for insects: in *Cyrtostylis* it is narrow, and quite plain; but the same end is attained by allowing the nectar slowly to trickle down each side of the midrib. The secreting glands at the base of the lip are much smaller than in the former species, while the papillæ on the margins and points are totally wanting. The column agrees with that of *Acianthus* in most features, but is broadly winged on each side. This may be of use as a protection to the stigma, or perhaps the projections serve as guides for the proper withdrawal and insertion of the pollen-masses, No difference worth mention is found in the stigma, or rostellum; and the mode of attachment of the pollinia to the latter organ appears to be precisely the same in both plants. In the shape of the pollen-masses themselves, however, we find a marked divergence, for instead of being nearly subdivided, as in *Acianthus*, they are simply falcate in shape. They are laterally much compressed, and extremely friable.

Notwithstanding the minuteness of the flowers, they are frequently visited by insects, chiefly minute species of Diptera. The pollinia, however, are not removed with the same regularity and precision as in *Acianthus*, nor is such a large proportion of capsules produced. I find, though, that specimens from some localities give very discordant results in this respect, although as a rule there can be no doubt that the proportionate number of capsules matured is much less thon in *Acianthus*.

I have made no observations on the fertilisation of the only other species of *Cyrtostylis* (*C. rotundifolia*) native to New Zealand. The difference between the two plants is so slight (if indeed it is sufficient to allow a specific distinction being maintained) that I can entertain no doubt but that, on investigation, the mode of fertilisation will be found to be the same for both species.

Art. LI.—*On* Pterostylis squamata *in New Zealand.*

By Thomas F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 27th July,* 1874.]

For the discovery of this singular plant in New Zealand, we are indebted to the late Dr. Sinclair, so well known for his successful researches into the natural history of this country. Specimens collected by him in some locality near Auckland were forwarded to Sir W. Hooker at Kew, about twenty-four years ago; and accordingly we find the plant described in the first volume of the Flora Novæ-Zealandiæ. Nearly the same description is reproduced in the more recently issued Handbook, but with no additional habitats attached. Unfortunately, no precise record appears to have been preserved of the station in which it was found; and consequently, on Dr. Sinclair's decease, the species became entirely lost to New Zealand botanists. Since then, although the vicinity of Auckland has been repeatedly searched, no traces of its presence have been observed, nor, until a few months ago, had it been found elsewhere in the colony. As the plant must undoubtedly be considered one of the rarest members of the New Zealand flora, and as it is structurally one of the most interesting, it seems not out of place to put the fact of its rediscovery on record.

During a recent visit to the Thames, while examining the low clay hills which skirt the river immediately behind the native settlement of Kapu, I observed a solitary *Pterostylis*, that on inspection proved to be the long-lost *P. squamata*. On a further search two more specimens were found, but both of these were barren. Unfortunately the time at my disposal was not sufficient to enable me to make a complete examination of the district, and to

ascertain definitely if the plant is abundant or rare in this, the only locality in New Zealand of which we have now any certain knowledge of its occurrence. It seems most probable, though, that it will prove to be far from common although isolated specimens will doubtless be met with.

Pterostylis squamata can be distinguished from its congeners in New Zealand by the very obvious character of the lateral sepals being turned downwards, instead of being erect. This distinction has been made use of to divide the genus into two sections; the first, *Antennæa*, to which the majority of the Australian and New Zealand species belong, having the sepals erect; the second, *Latochilus*, which includes our plant, having them deflexed Another excellent character is afforded by the labellum, which is filiform and hangs out of the mouth of the flower. It is also clothed throughout its whole length with copious golden-yellow hairs, except at the apex, where it bears a curious large purple gland, which has been aptly compared to the head of a nail.

Although *Pterostylis squamata* is rare and local in New Zealand, it is comparatively common in Tasmania, and is also found in Victoria and South-Western Australia. In this respect it agrees with *Epacris purpurascens* and *Leucopogon richei*, both of which are abundant Australian plants, and both of which are confined to limited areas in New Zealand.

It is worth remarking that the affinity existing between the temperate Australian and New Zealand floras, easily recognised except in a few anomalous instances, is perhaps more clearly shown in the Orchideæ of the two countries, than in any other order of equal extent. Thus, in examining the distribution of the eighteen genera found in New Zealand, we find that no less than sixteen also occur in Australia, while the two remaining ones, although peculiar to New Zealand, are yet closely related to Australian forms. This result, striking in itself, becomes more so if we look closely into it, when it appears that out of the sixteen, six are absolutely peculiar to the two countries, and six others, although possessing outlying species in the Indian Archipelago or Pacific Islands, yet plainly have their head-quarters in Australia and New Zealand. *Pterostylis* is a good instance of this. It has twenty-four species in Australia, and seven in New Zealand. One of the Australian species extends into New Caledonia, but beyond this the genus is endemic in the two countries.

In the sixth volume of the Flora Australiensis, recently issued, I observe that Mr. Bentham considers the true *P. squamata* of R. Brown to be a form only of the *P. rufa* of the same author; and the plant to which the specific name of *squamata* has been, in many instances, applied by later botanists, is referable to a species long ago described by Dr. Lindley. If this view should meet with the general acceptation of botanists, as seems likely, our plant will in future bear the name of *Pterostylis barbata*, Lindley.

Art. LII—*A Description of some new Species of* Gymnostomum.

By Charles Knight, F.R.C.S., F.L.S.

[*Read before the Wellington Philosophical Society, 29th August,* 1874.]

1. *Gymnostomum patulum*, n. s.

Caulis *brevis.* Folia sicca crispata anguste lanceolato-linearia *basi vix latiora* margine *subapicem erecta,* nervo virido *in acumen producto* e cellulis minutis rotundatis chlorophyllo repletis basi parallelogrammis laxioribus areolata; perichætiala longiora erecta linealia. Theca in *pedunculo brevi* elliptica, orificio membrana clauso, operculo oblique subuli-rostro.

Stems short. Leaves crisped lanceolato-linear scarcely wider at the base, the margin erect under the apex, nerve green excurrent, point aristate, areolæ formed of minute rounded cells filled with chlorophyl, towards the base more lax and four-sided, the perichætial leaves longer, erect. Fruit-stalk no longer than the perichætial leaves. Capsule elliptic, the mouth closed by a membrane, operculum oblique with an awl-shaped beak.

2. *Gymnostomum knightii*, n. s. *Schimp. in litt.*

Caulis perbrevis. Folia *linguæformia* carinata, *margine e basi ad apicem recurva,* ubique e cellulis minutis pellucidis rotundatis areolata, nervo crasso *infra apicem evanido.* Theca in pedunculo medio erecta oblonga sicca cylindrica, operculo rostrato, et thecæ orificium membranâ non clausum.

Stem very short. Leaves tongue-shaped, keeled, margins recurved from base to apex. Areolæ minute, round, pellucid, nerve stout, vanishing below the apex. Capsule oblong, erect, mouth not closed by a membrane. Operculum beaked.

3. *Gymnostomum calcareum* var. *intermedium.*

Plantæ *densissime cæspitosæ gracillimæ,* inferne ferrugineæ. Folia minuta erecta crispula lanceolato-linearis *mutica* obtusa concava, *abrupte evanidinervia,* margine minute crenulata et circum apice erecta, e cellulis basi rectangularibus pellucidis superne rotundatis parvis papillosis areolata. Theca ovali-cylindrica; *ore e cellulis transverse angustatis pluriseriatis formato.*

Stems densely cæspitose, slender, ferruginous below. Leaves minute, erect, crisped when dry, linear-lanceolate, concave, obtuse, with a mucro. Margin minutely crenulate, erect round the blunt apex; nerve ceasing below the apex. Capsule cylindrical when dry, the mouth formed by several series of narrow cells.

This moss differs greatly from *Seligera calcarea,* Br. et Sch., to which Hooker refers it. The latter has a yellow-red coloured peristome with broad flat teeth, stout bars, without a median line.

Explanation of Plate XXVIII.

1. *Gymnostomum patulum.*

   Plant nat. size, and capsule enlarged.

   a, b. Leaves enlarged.

   c, d, e. Portion of leaves greatly enlarged.

2. *Gymnostomum knightii.*

   Capsule enlarged.

   a, b. Leaves enlarged.

   c, d. Portion of leaves greatly enlarged.

3. *Gymnostomum calcareum* var. *intermedium.*

   Capsule enlarged.

   a, b. Leaves enlarged.

   c. Portion of leaf greatly enlarged.

4. *Gymnostomum sulcatum.*

   Plant enlarged.

   a. Operculum and calyptra enlarged.

   b, c, d. Leaves enlarged.

   e. Portion of leaf greatly enlarged.

5. *Gymnostomum areolatum.*

   Plant enlarged.

   a. Leaf enlarged.

   b. Portion of leaf greatly enlarged.

6. *Gymnostomum angustatum.*

   Capsule enlarged.

   a, b. Leaves enlarged.

   c. Portion of leaf greatly enlarged.

C. Knight. del. J.B. lith.

4. *Gymnostomum sulcatum*, n. s.

Dense cæspitosum erectum *gracillimum innovando-ramosum*, folia parva dense conferta minutissime papillosa carinata crispula madefacta patentia-erecta lanceolata *apiculata evanidinervia*, margine plana v. parum recurva, e cellulis *parvis incrassatis* areolata. Theca ovalis in pedunculo *brevi* erecta *sulcato-striata*, operculo conico subobliquo-rostrato.

Crowded, erect, very slender, branched. Leaves crowded, minutely papillose, keeled, crisped (when moistened patentia-erect), lanceolate, apiculate, nerve vanishing, margin flat or slightly recurved. Areolæ small. Capsule oval, erect, striate, on a short fruit-stalk. Operculum conical with an oblique awl-shaped beak.

5. *Gymnostomum areolatum*, n. s.

Gregarium brevissimum, folia concava laxiuscula crispula madefacta erecto-patentia *elongato-oblonga v. subspatulata* apiculata v. acuminata, ubique e cellulis *amplis* pellucidis tenuissime papillosis superne rotundato-angulatis v. quadratis areolata, nervo ad apicem fere extimum perdurante. Theca ovata in pedunculo brevi erecta, operculo conico subobliquo rostrato.

Plants crowded, stem very short. Leaves concave, lax, crisp, when moistened erecto-patent, elongato-oblong or subspatulate, apiculate or acuminate; areolæ throughout large, pellucid, papillose, towards the point rotundato-angular, nerve extending to the apex. Theca ovate, erect, on a short fruit-stalk, operculum conical with an oblique beak.

6. *Gymnostomum angustatum*, n. s.

Plantæ *humiles*. Folia madefacta patentia curva papillosa *linealia obtusa*, margine erecta, nervo dorso prominente *infra apice evanido*. Theca erecta ovalis; operculum e basi conica in rostrum subulatum continuatum.

Plants small. Leaves (when moistened, spreading, curved), papillose, linear, obtuse, margin erect, nerve prominent at the back, vanishing below the apex. Theca erect, oval, operculum with an awl-shaped beak continued from the conical base.

Art. LIII.—*Description of some New Zealand Lichens.*

By Charles Knight, F.R.C.S., F.L.S.

Plate XXIII.

[*Read before the Wellington Philosophical Society, 21st November,* 1874.]

1. *Phlyctis egentior*, Nyl.

Thallus tenuissimus, livido-cineraceus, sat determinatus. *Apothecia* innata parva flavo-fusca rotundata aut difformia, margine thallino pulverulento cincta, disco plano brunneo sæpius pulverulento. *Sporæ* incolores falcatæ 7–9-septatæ, longit. 0·062 mm., crassit. 0·007 mm.

Ad cortices arborum.

Thallus very thin, livido-cineraceous, somewhat determinate. Apothecia innate, small, yellowish-brown, rounded or misshaped, bound by a powdery thalline margin. Spores colourless, falcate, 7–9-septate, length 0·062 mm., breadth 0·007 mm.

Differs from *Phlyctis andennis* and *P. brasilensis* in the colour of the thallus, and probably, by the powdery thalline margin with which the apothecia are bound.

2. *Phlyctis neo-zelandia*, Nyl.

Thallus crustaceus, uniformis, albus, tenuis vel crassus, late expansus, rimosus, determinatus. *Apothecia* minuta, innata, maculiformi-difformia, concaviuscula, carnea, excipulo proprio nullo—nisi margine thallino spurio extus pulverulento—cincta. *Sporæ* incolores, vermiformi-cylandraceæ, spiraliter curvatæ, 7–11-septatæ, longit. 0·07 mm., crassit. 0·005 mm.

Ad corticem arborum.

Thallus crustaceous, uniform, white, thin or thick, widely expanded, rimose, determinate. Apothecia minute, innate, concave, flesh-coloured, without a proper excipulum, surrounded by a pulverulent thalline margin. Spores colourless, spirally curved, 7–11-septate, 0·07 millim. long., 0·005 millim. thick.

On bark.

3. *Lecidea stellulata*, Taylor.

Thallus albidus, tenuissimus, areolato-diffractus, hypothallo nigro manifesto inter areolas. *Apothecia* sessilia, nigra. *Sporæ* fuscæ vel nigræ, uni-septatæ, longit. 0·01 mm., crassit. 0·006 mm.

Ad saxa.

Thallus white, very thin, areolate-diffractate, hypothallus black, visible between the areolæ. Apothecia sessile, black. Spores brown or black, 1-septate, 0·01 millim. long., 0·006 millim. thick.

On rocks.

3*. *Lecidea parasema*, Ach.

L. parasema, Ach. (Nyl. in Lich. Scand. p. 217), described in Handbook N.Z. Fl., p. 584, I have not succeeded in collecting in New Zealand, and it is most likely that the common lichen, *L. myriocarpa*, DC., has been mistaken for it. This latter plant is common in New Zealand, although not described in the Handbook. The thallus is ashy-green, thin, subgranular, and determinate. The apothecia small and margined. Spores uniseptate, brown, 0·013 millim. long, and 0·008 millim. broad. Hypothecium black or obscurely brown.

Syn. *L. punctata*, Schœr. Exs. 197, and *L. punctata* g. *denudata*, Schœr. Exs. 529.

It is true that our lichen agrees with those in the collections of Leighton from Great Britain, and others from Germany and Scandinavia, under the name of *L. parăsema*, but in every specimen that I examined of those collections the character agrees with *L. myriocarpa*, to which species in fact they belong.

4. *Lecidea radomma*, Nyl. *in litt.*

Thallus cinereus, granulosus. *Apothecia* atra, superficialia, mediocria, plana, margine prominente. *Sporæ* octonæ, incolores, ellipsoideæ, biloculares, plerumque tubulo loculos jungente, longit, 0·025 mm., crassit. 0·015 mm. Stratum hypothecii subhymeniale fuscum, stratum excipulare album.

Ad cortices arborum.

Thallus ashy, granular. Apothecia black, superficial, medium size, flat, with prominent margin. Spores eight in each ascus, colourless, ellipsoid, bilocular, cells united by a tube, 0·025 millim. long, 0·015 millim. thick. Subhymeneal stratum brown, excipular stratum white.

On bark of trees.

Differs from *L. leucoplaca*, Chev., in the excipulum being white, and the spores mostly with a connecting tube between the cells.

5. *Lecidea marginiflexa.*

Montague considers this plant to be *L. tuberculosa*, Fée (Flora N.Z., p. 299). This is a mistake. Fée's lichen has multilocular spores, while *L. marginiflexa* has uniseptate spores and only one spore in each ascus.

Lecanora parella var. *implicata.*

Differs from the typical form in the thallus being neither granular nor warty, but rugose. In this it resembles a corticular specimen collected by J. P. Norlin at Tavastia Asikkala. The disk is more coloured than usual in Buchanan's specimen, and is convex or flat in the full grown apothecia, as is sometimes the case in *L. tartarea.* Specimens are seen in all stages between slightly rugose and warty. One, which Nylander has named *L. thelotremoides*, is clearly intermediate between *L. implicata* and *L. parella.*

Syn. *Lecanora implicata*, Stirton.

6. *Lecidea fusco-lutea,* Dickson.

Thallus albus, granulosus. *Apothecia* magna, sordide lutea vel liventia, plana, prominente marginata. *Ascis* unam sporam oblongam grandissimam minutissime muricatam foventibus.

Thallus white, granular. Apothecia large, dull yellow or liver-coloured, disk flat with a prominent margin. Asci with one large muricated spore, 0·188 millim. long, 0·052 millim. thick.

The *Lecidea fusco-lutea* of Acharius has bilocular spores, the cells connected by a tube. See Schœrer Exs. 215 (*L. ferruginea* b. *leucorrhœa*).

7. *Lecidea leucoplaca,* Chev.

Thallus cinereo-virescens, effusus, granulatus vel granulato-rugosus. *Apothecia* exserta, disco plano et margine prominente, stratum hypothecii subhymeniale et stratum excipulare nigra, lineo ochro-fusco disjuncta. *Sporæ* 8næ, incolores, ellipsoideæ, biloculares, longit. 0·025 mm., crassit. 0·012 mm.

Syn. *L. premnea,* Fries. *L. grossa,* Nyl. (in litt.) *L. maculosa,* Stirton *L. melastegia,* Nyl. *L. melaclina,* Nyl. Leighton Exs. 125 ! 90 !

Ad cortices arborum.

Thallus ashy-green, effuse, granular or granulo-rugose. Apothecia exserted, with flat disk and prominent margin, the subhymeneal stratum of hypothecium and excipular stratum black and separated by a yellowish-brown line. Spores 8 in each ascus, colourless, ellipsoid, bilocular, 0·025 millim. long, 0·012 millim. thick.

I have examined specimens in Mr. Buchanan's collection—whence Dr. Stirton's lichens were obtained—and find no difference between *L. maculosa,* Stirt., and *L. leucoplaca,* Chev. The measurements of the spores given by Dr. Stirton would answer for *L. parasema,* Nyl. Lich. Scand.

8. *Lecidea versicolor,* Fée, var. *subtuberculosa,* Knight.

Thallus subtuberculosus, pallido-stramineus. *Apothecia* sparsa, fusca, marginata, margine concolore. *Sporæ* pallido-luteæ, uniseptatæ, ovatæ, longit. 0·038 mm., crassit. 0·024 mm. Hypothecium pallido-flavidum.

Ad cortices.

Thallus subtuberculose, pale straw. Apothecia scattered, brown, margined; margin concolorous. Spores pale yellow, 1-septate, ovate, 0·038 millim. long, 0·024 millim. thick. Hypothecium pale yellow.

On bark of trees.

It is not unlikely that *L. taitensis,* Mont., and *L. versicolor,* Fée, are the same plant. If so the varieties in New Zealand are (1) *L. taitensis* with rugose thallus, and spores 0·075 mm. in length, and margin of apothecium much darker than the ashy-brown disk; (2) *L. versicolor* with pale border and brown disk, spores ·05 mm. in length, hypothecium white, and thallus tuberculoso-

isidiose; and (3) *L. taitensis* var. *subtuberculosa*, with smoother thallus, the disk and margin of the apothecium brownish-black, spores 0·033 mm. in length, and hypothecium pale yellow.

In *L. marginiflexa* the asci contain only one spore in each and that linear oblong and bilocular. In *L. fusco-lutea*, Dicks., also, the asci contain only one spore in each, but that is linear oblong or cylindrical, and minutely muricated.

8c. *Lecidea versicolor*, Fée.

Thallus albus, granulato-inæqualis vel granuloso-isidiosus. *Apothecia* disco fusco, et margine pallido, tumido, undulato. *Sporæ* uniseptatæ, ovatæ, incolores, longit. 0·05 mm., crassit. 0·023 mm. Hypothecium album.

Ad corticem arborum.

Thallus white, granulose, unequal, or granular-isidiose. Apothecia with brown disk, and pale tumid wavy margin. Spores 1-septate, ovate, colourless, 0·05 millim. long, 0·023 millim. thick. Hypothecium white.

9. *Lecidea taitensis*, Mont.

Thallus cineraceus vel eborinus, granulatus vel verrucoso-rugosus, passim rimulosus. *Apothecia* disco fumeo, et margine fusco-atro, tumido, undulato. *Sporæ* pallido-luteæ vel incolores, magnæ, ovatæ, incurviusculæ, uniseptatæ, longit. 0·075 mm., crassit. 0·035 mm. Stratum hypothecii subhymeniale incolore, perithecium fuscum.

Ad corticem arborum.

Thallus greyish or cream-coloured, granulate or warty rugose, here and there rimulose. Apothecia greyish-brown, and margin brownish-black, tumid, wavy. Spores pale yellow or colourless, large, ovate, little incurved, 1-septate, 0·075 millim. long, 0·035 millim. thick. Hymeneal stratum of hypothecium colourless; perithecium brown.

On bark.

10. *Lecanora contigua*, Ach., var. *meiospora*, Nyl.

Thallus albus vel cineraceus, areolatus, lineâ fuscâ limitatus. *Apothecia* sessilia, convexa, fusco-nigra, immarginata. *Sporæ* incolores, ellipsoideæ, longit. 0·014 mm., crassit. 0·008 mm. Hypothecium fusco-nigrum.

Ad saxa et supra terram argillaceam.

Thallus white or ashy-white, areolate or cracked, bounded by a dark line. Apothecia sessile, convex, brownish-black, immarginate. Spores colourless, ellipsoid, 0·014 millim. long, 0·008 millim. thick. Hypothecium brownish-black.

On rocks and clayey banks.

11. *Lecidea melanotropa*, Nyl.

Thallus fractus, granuloso-inæqualis vel granuloso-rimosus, in aliquot

exemplis sublævis, albidus vel pallido-cinereus vel cinereo-flavus. *Apothecia* nigra vel cæsio-pruinosa vel cæsio-pallentia, plana, demum convexa; margine obtuso, ceraceo-pallido, quandoque subconcolori. *Sporæ* incolores, ellipsoideæ, interdum incurvæ, sæpius utroque apice acutiusculæ, longit. 0·014 mm., crassit. 0·007 mm. Hypothecium incolor.

Ad cortices arborum.

Thallus cracked, unequally granular, or granuloso-rimose, sometimes rather smooth, white, or pale-ashy or ashy-yellow. Apothecia black or bluish pruinose, at length convex; margin broad, waxlike, pale, now and then of one colour with the disk. Spores colourless ellipsoid, sometimes incurved, often rather acute at either end, 0·014 millim. long, 0·007 millim. thick. Hypothecium colourless.

The character of the thallus and the colours of the apothecia vary greatly, but nevertheless nearly all the variations of the latter may be found in one and the same plant. The thallus varies according to the nature of the bark it grows on. A variety named by Dr. Nylander (in a letter) *Lecidea cæsio-pallens*, Nyl., is best treated as a distinct variety.

12. *Lecidea planella*, Nyl. Syn. Lich. Novæ-Caledoniæ, p. 45.

Thallus cinereo-virescens, effusus, tenuissimus vel evanescens, et sæpius vix ullus. *Apothecia* adpressa vel peltata, albida vel carneo-pallida vel carneo-lutea vel carneo-cinnabarina, sæpius undulato-difformia; margine paulo dilutiore, evanescente, (latit. 0·1 mm. ad 0·25 mm.). *Sporæ* octonæ, uniseriales, incolores, fusiformes, uniseptatæ, longit. 0·008 mm., crassit. 0·002 mm. Paraphyses mediocres, apice clavato. Hypothecium incolor.

Ad cortices fruticium et filicium et supra muscos.

Syn. *Bæomyces pertenuis*, Stirton. *Biatora cinnabarina*, Bab., Flora N.Z., p. 300.

Thallus ashy green, effuse, very thin, frequently scarcely any. Apothecia appressed or peltate, white or pale fleshy-coloured or fleshy-yellow or fleshy-cinnabar, often undulate and irregular in outline, margin somewhat paler, evanescent, (diameter 0·1. ad 0·25 mm.). Spores 8 in each ascus, in one row, colourless, fusiform, 1-septate, 0·008 millim. long, 0·002 millim. thick. Paraphyses club-shaped, apex nearly as broad as ascus.

On bark of shrubs and ferns, and on mosses.

I have no doubt that this is the *Biatora cinnabarina* of Babington (Flora N.Z., p. 300), and certainly the *Bæomyces pertenuis* of Stirton. After examining specimens from Mr. Buchanan's collection, and numerous specimens in my own, I have met with no instance of spores with four cells in one case; there is an appearance of four divisions, but no more than one true septa. The lichen agrees in every particular with Nylander's description. The spores in plate 129 C., Flora N.Z., should be uniseptate.

J. Knight del. J.B. lith.

13. *Lecidea plesia*, Knight.

Thallus ochroleucus, tenuis, areolo-rimosus. *Apothecia* nigra, plana, mediocria, elevato-marginata, margine flexuosa vel subanguloso-difformia. *Sporæ* lineari-clavatæ, 4–5-septatæ, incolores vel diluto-fuscentes, longit. 0·032 mm., crassit. 0·011 mm. Hypothecium nigrum.

Ad saxa.

Thallus pale ochrey colour, thin, divided into areolæ by chinks. Apothecia black, plane, medium size; margin raised, flexuose or subangularly deformed. Spores linear, clavate, 4–5-septate, colourless or pale brown, 0·032 millim. long, 0·011 millim. thick. Hypothecium black.

Differs from *L. contigua* in colour of thallus and the multilocular, lineari-clavate spores; from *L. sabuletorium*, whose spores are elongate fusiform.

14. *Lecidea allotropa*, Nyl.

Thallus continuus, tenuissimus, cineraceus. *Apothecia* sessilia, planiuscula, demum convexa, immarginata, nigra, sat parva. *Sporæ* oblongæ, 3-septatæ, longit. 0·015 mm., crassit. 0·006 mm. Stratum hypothecii subhymeniale incolore, stratum inferiore album.

Thallus continuous, very thin, greyish. Apothecia sessile, flat, at length convex, immarginate, black, rather small, spores oblong, 3-septate, 0·015 millim. long, 0·006 mm. thick. Subhymeneal stratum of the hypothecium colourless, the inferior white.

14.* *Pannaria periptera*, sp. n.

Thallus monophyllus, plumbeus, orbicularis, e laciniis linearibus ferme adpressis flabelliformibus multifidis radiantibus compositus, centro concreto. *Apothecia* rubro-fuscentia, plana, margine duplici cincta, (excipulo a thallo crenulo marginato). *Sporæ* incolores, ellipsoideæ, simplices, longit. 0·013 mm., crassit. 0·0075 mm.

Ad cortices arborum.

Thallus monophyllous, lead colour, round, formed of linear, firmly pressed, fan-shaped, radiating laciniæ, coalesced in centre. Apothecia reddish-brown, flat, bound by double margin—the proper excipulum surrounded by a crenulate thalline margin. Spores colourless, ellipsoid, simple, 0·013 millim. long, 0·0075 mm. thick.

On bark of trees.

Named by Dr. Nylander (in a letter) *Coccocarpia periptera*. One of the most distinctive characters of the *Coccocarpiæ* is the adnate, immarginate apothecia; it would, therefore, be unsatisfactory to place among the species of that genus a lichen with two distinct raised margins to the apothecia—a thallodal one enclosing a sharply defined excipulum. It is true that like *C. smaragdina* the thallus is furnished with gonimia in lieu of gonidia; but

both *Pannaria* and *Coccocarpia* agree in that character. As to our lichen being monophyllous, this is a very uncertain and questionable character. Many specimens of it can no more be considered monophyllous than *P. rubiginosa*, which latter has never been treated as a *Coccocarpia*, although its close ally *C. plumbea*, Nyl., is by Nylander. I agree with Dr. Lauder Lindsay that Nylander's arrangement, which separates *P. rubiginosa* from *P. plumbea*, is a most artificial and unnatural one (*vide* Trans. Roy. Soc. Edinb., vol. xxii part 1. p. 256).

15. *Lecanora flavo-pallescens*, sp. n.

Thallus tenuis, subgranulosus, flavo-albicans, interdum evanescens. *Apothecia* biatorina, disco fulvo plano tandem tumido, marginem pallidum levem demum excludente. *Sporæ* simplices, incolores, longit. 0·015 ad 0·02 mm., crassit. 0·01 ad 0·013 mm.

L. flavo-pallescens, Nyl. in litt.

Ad ligna. Grandibus sporis satis dignoscitur.

Thallus thin, subgranular, yellowish-white, sometimes evanescent. Apothecia biatorine, buff or tawny, disk flat, at length tumid, overlapping the pale smooth thalline border. Spores simple, colourless, 0·015 to 0·02 millim. long, 0·013 millim. thick. Closely allied to *L. varia*, if not a variety. The specimens with tumid apothecia resemble *L. symmetrica*, but differ from it and from all varieties of *L. varia* in the smooth thalline border of the apothecia, and especially in the much larger size of the spores, which in none of the varieties of *L. varia* in Leighton, Schœrer, and several German collections that I have examined, exceed 0·011 mm. in length. *L. varia* is a most polymorphous species. The numerous varieties may be arranged in four sets.

(1). Those with larger apothecia crowded together, with bold granular flexuose or angular margin, growing on wood, viz:—*Parmelia varia*, Ehrh. var. *vulgaris*, Korb., Leight., Exs. 51; *Lecanora varia* var. *pallescens*, Schœr., Exs. 325.

(2). Those with minute apothecia, with pallid powdery margin and flat disk, sometimes a little convex, viz:—*Lecanora varia* var. *hypopta*, Ach.; *L. aitema*, Ach.; *L. apocræa*, Ach.; *L. sarcopis*, Ach.; *Parmelia varia*, Leight., Exs. 176.

(3). Those with tumid apothecia, viz:—*Lecanora varia* var. *symmetrica*, and other varieties.

(4). *Lecanora varia* var. *polytropa*, with its varieties, growing on stones.

16. *Lecanora thiomela*, Nyl.

Thallus crustaceus, citrinus, areolatus, areolis hypothallum fuscum obtegentibus, linea fusca limitatus. *Apothecia* minuta, cupulæformia, marginata, nigra, margine thallino citrino cincta. *Sporæ* fuscentes, ellipsoideæ, uni-septatæ,

longit. 0·017 mm., crassit. 0·01 mm.

Ad saxa.

Thallus crustaceous, citrine, areolate, areolæ covering the brown hypothallus, bordered by a dark line. Apothecia minute, black, bound by a citrine-coloured thalline margin. Spores brown, ellipsoid, 1-septate, 0·017 millim. long, 0·01 millim. thick.

17. *Ascidium melanosporum*, sp. n.

Thallus crustaceus, verrucosus, eborinus. *Apothecium* hemisphericum, apice depresso-umbilicatum. Perithecium nigrum, globosum, apice poro pertusum. Nucleus paraphysibus tenuibus farctus. Thecæ mono-sporæ. *Spora* magna, fusiformis, multicellulosa vel muricata, demum fusca, opaca, longit. 0·18 ad 0·25 mm., crassit. 0·065 ad 0·09 mm.

Ad corticem arborum.

Thallus crustaceous, verrucose, cream-coloured. Apothecium hemispherical, depressed at the apex. Perithecium black, globose, opened by a pore at the apex. Nucleus with slender paraphysis. Theca 1-spored. Spore large, fusiform, many-celled or muricated, at length brown, opaque, 0·18 to 0·25 millim. long, 0·065 to 0·09 millim. thick.

On bark of trees.

Differs from *A. domingense* and *A. cinchonarum*, in the spores being irregularly cellular, much broader, and at length quite opaque. (*Vide* Tab. 1, fig. 20, Nyl. Prod. Flores Novo-Granatensis, Lichenes.)

18. *Melaspilea metabola*, Nyl. Lich. Novæ Caledoniæ, p. 69.

Thallus cinereus, diffracto-rimosus vel areolatus, tenuissimus. *Apothecia* nigra vel fusca, mediocria, rotundato-lecideoidea (juniora punctiformia), convexa, immarginata, intus pallido-incoloria. *Sporæ* incolores, cylindraceæ, inferne magis attenuatæ et curvatulæ (sæpe in capillam productæ), murali-divisæ, longit. 0·075 ad 0·1 mm., crassit. 0·01 mm.

Ad cortices arborum.

Thallus ashy, cracked or areolate, very thin. Apothecia black or brown, medium size, rotundato-lecideoid—younger mere spots—convex, immarginate, pale within. Spores colourless, cylindrical, curved, attenuated below, often terminating in a hair, muriculate, 0·075 to 0·1 millim. long, 0·01 millim. thick.

On bark.

19. *Squamaria perrugosa*, Nyl.

Thallus cinereo-fuscus vel cinereo-rufescens, adpressus, tesselato-areolatus, areolis in centro depressis, versus peripheriam laciniato-divisus, laciniis pterygioideo-expansis. *Cephalodia* cerina vel ochraceo-rufescentia, demum in radios fissa. *Apothecia* ochro-badia, concava; excipulum proprium marginem

thallinum cinctum. *Sporæ* uniseriales, incolores, ellipsoideæ, simplices evl perrarò biloculares, longit. 0·013 mm., crassit. 0·008 mm.

Ad saxa.

Thallus ashy-brown or ashy-red, closely adhering to matrix, tesselato-areolate, areolæ depressed in centre, divided towards circumference into laciniæ, laciniæ expanded, wing-like. Cephalodia dull yellow or yellowish-red, at length split into rays. Apothecia yellowish-brown, concave. Proper excipulum surrounded by thalline border. Spores in a single row, colourless, ellipsoid, simple, or very rarely 2-celled, 0·013 millim. long, 0·008 millim. thick.

Syn. *Squamaria thaumasta*, Stirton.

Section of apothecium shows the proper excipulum of a pale colour, bound by a thalline border.

20. *Squamaria perrugosa*, Nyl., var. *neglecta*, Knight.

Thallus cinereo-albescens, granulato-verrucosus, crustaceo-adnatus, centro confusus, versus peripheriam lobulo-crenatus vel pterygioideo-expansus. *Apothecia* rosea, farinosa, margine thallino crasso, tumido, farinoso, obsolete crenato cincta. *Cephalodia* convexa, irregulariter fissa. *Asci* prælongi, angusti. *Sporæ* uniseriales, octonæ, ellipsoideæ, simplices, pellucidæ, longit. 0·027 mm., crassit. 0·013 mm.

Ad saxa.

Similis *L. perrugosæ*, sed sporis subgrandibus facile ab eo distinguitur.

Thallus greyish-white, granulate with warts, closely attached to matrix, centre confused, towards circumference lobulato-crenate, or outspread wing-like. Apothecia rose-coloured, farinaceous, bordered by a thick, swollen, obsoletely crenate margin. Cephalodia convex, irregularly split. Asci very long and narrow. Spores in one row, ellipsoid, simple, pellucid, 0·027 millim. long, 0·013 mm. thick.

On rocks.

Differs from the typical form in the larger size of the spores, and the characters of the thallus.

Lecidea campylospora, Stirton, is the *Lecanora taitensis*, Mont., as determined for me some years since by Dr. Nylander.

Lecidea maculosa, Stirton, is the *L. leucoplaca*, Chev. ; *L. premnea*, Fries. ; *L. grossa*, Nyl. in litt. ; *L. melastegia*, Nyl. Leighton's Exs. 90 ! 125 !

Melaspilea amphorodes, Stirton, is the *M. metabola*, Nyl. Syn. Lich. Nov. Cal. p. 69.

Lecidea (Lecanora ?) implicata, Stirton, is the *Lecanora thelotremoides*, Nyl. in litt.

Astrothelium prostratum, Stirton, is the *A. ochrocleistum*, Nyl. in litt.

NOTE.—In reference to Dr. Stirton's description of certain New Zealand lichens, published in the Transactions of last year, page 235, I find that the *Bæomyces pertenuis*, Stirton, is the *Lecidea planella*, Nyl., described in Dr. Nylander's Synopsis Lichenum Novæ Caledoniæ, p. 45.

Psoroma implexa, Stirton, is the *P. sphinctrina* var. *pholidotoides*, Nyl. Journ. Linn. Soc. p. 244. A careful examination of specimens of Dr. Stirton's lichen in the collection of Mr. Buchanan discloses no difference between them and Dr. Nylander's description. It grows on bark or trees, not on rocks as (inadvertently?) stated in Dr. Stirton's description. It is to be observed that the same specimen may exhibit here and there simply a broad black boundary line, and in other parts coarse black dendritic radiating fringe.

Psoroma arthrophyllum, Stirton. This is a coarse variety of *P. subpruinosum*, Nyl. Like many common lichens the *P. subpruinosum* has many varieties. They all agree in one respect—their spores are spherical or oval, with no tendency to be pointed at the ends. In the same ascus are often found both descriptions of spores intermixed. In such instances it may be that the spherical appearance is due to the spore lying transversely in the ascus, when it would be seen "end on,"—but I am not sure that such is ever the case.

Squamaria thaumasta, Stirton. This is the *Sq. perrugosa*, Nyl., of which a full and excellent description is given by Dr. Nylander in the Linnean Journal above quoted. The scales of the thallus instead of being umbate are most frequently somewhat depressed in the centre. The spores are strictly uniserial and simple. Very rarely an uniseptate spore may be met with. This lichen is closely allied to *Sq. gelida*, Linn.

These and most other lichens cannot be satisfactorily studied without the aid of a microscope. The dimensions and figure of the spores, the distinction between *gonidia* and *gonimia* of Nylander, and other differences, can only be determined by a good microscope. Dr. Hooker in the Handbook of the N.Z. Flora, especially alludes to the excellent specific characters afforded by the spores, but it would, he adds, take many months of microscopic study to ascertain accurately the size of the spores of New Zealand lichens. He has in numerous instances given references to Dr. Nylander's works where the dimensions are given. I have taken the measurements of the spores of most of the New Zealand lichens, and find them to agree with those stated by Dr. Nylander in his work on the Lichens of Scandinavia.

Description of Plate XXIII.

Fig. 1. *Phlyctis egentior*, Nyl.
Section of thallus and apothecia.
a, 7–9-septate spores.

2. *Phlyctis neo-zealandia*, Nyl.
Section of thallus and apothecia showing asci and paraphyses.
a, Ascus and spores. *b*, 7–11-septate spores. *c*, do. do. of different form.

3. *Lecidea stellulata*, Taylor.
Ascus and spores. *a*, 1-septate spores.

3* *Lecidea myriocarpa*, DC.
Section of portion of thallus with apothecia.
a, Section of hymenium with ascus and paraphyses. *b*, 1-septate spore.

4. *Lecidea radomma*, Nyl.
Section of thallus and apothecia.
a, Ascus and spores. *b*, Ascus and spores. *c*, Bilocular spore.

5. *Lecidea marginiflexa*, Taylor.
Section of portion of thallus with apothecia.
a, 1-septate spore. *b*, 1-septate spore.

6. *Lecidea fusco-lutea*, Dickson.
Section of portion of thallus with apothecia.
a, Muricated spore. *b*, Muricated spore.

7. *Lecidea leucoplaca*, Chev.
Section of portion of thallus with apothecia.
a, Ascus with spores. *b*, do. do. *c*, 1-septate spore. *d*, do. do.

8. *Lecidea versicolor*, Fée, var. *subtuberculosa*, Knight.
Section of portion of thallus with apothecia.
a, 1-septate spore. *b*, do. do.
8*c*, *Lecidea versicolor*, Fée, 1-septate spore.

9. *Lecidea taitensis*, Mont.
Section of portion of thallus with apothecia.
a, Ascus with spores. *b*, 1-septate spore. *c*, do. do.

10. *Lecanora contigua*, Ach., var. *meiospora* Nyl.
Section of apothecia.
a, 1-septate spore. *b*, Spores, different forms.

11. *Lecidea melanotropa*, Nyl.
Section of thallus and apothecia.
a, 1-septate spore. *b*, spores, different forms.

12 *Lecidea planella*, Nyl.
Section of portion of thallus with apothecia.
a, Ascus with spores. *b*, Spores. *c*, Ascus with spores.

13. *Lecidea plesia*, Knight.
Section of thallus and apothecia.
a, 4–5-septate spores. *b*, Ascus and spores. *c*, Spores.

14. *Lecidea allotropa*, Nyl.
Section of apothecia.
a, Ascus with spore.

14* *Pannaria periptera*, sp. n.
Section of portion of thallus with apothecia.
a, Ascus with spores. *b*, do. do. and paraphysis. *c*, Spores.

15. *Lecanora flavo-pallescens*, sp. n.
Section of thallus with apothecia.
a, Ascus with spores. *b*, Spore.

16. *Lecanora thiomela*, Nyl.
Section of portion of thallus with apothecia.
a, Ascus with spores. *b*, do. do. *c*, Spore. *d*, do.

17. *Ascidium melanosporum*, sp. n.
Section of apothecium.
a, Spore. *b*, do.

18. *Melaspilea metabola*, Nyl.
Section of portion of thallus with apothecia.
a, Ascus with spores. *b*, Spore.
19. *Squamaria perrugosa*, Nyl. (young state.)
Section of portion of thallus with apothecia.
* Section of apothecia. *a*, Ascus with spores. *b*, do. do. *c*, do. do.
20. *Squamaria perrugosa*, Nyl., var. *neglecta*, Knight.
Ascus with spores.

ART. LIV.—*Description of a new Lichen* (Stereocaulon buchanani).

By JAMES STIRTON, M.D.*

Plate XXV.

[*Read before the Wellington Philosophical Society*, 21*st November*, 1874.]

A FEW days ago I received from Mr. J. Buchanan of the Colonial Museum, Wellington, a lichen which presents peculiarities of internal organization of sufficient importance to warrant a special notice. As these peculiarities are somewhat anomalous, the absence of spermogonia in the specimens is so far a matter of regret, inasmuch as its generic place is rendered to a certain extent doubtful.

Of late these secondary organs of fructification have been occupying considerable attention, and the modifications in size and shape of the spermatia, as well as the comformation and appearance of the spermogonia themselves, have served, in doubtful cases, as a means of discriminating genera, more especially *Lecanora* from *Lecidea*.

The lichen in question occupies an isolated position, and presents affinities to three genera, viz :—*Gomphillus*, *Stereocaulon* and *Bæomyces*.

In the extreme length and tenuity of its spores, the former dimension reaching almost the limit, in this respect, amongst lichens; in the tenacious stiff gelatine which prevades the hymenium, and almost conceals the paraphyses until the application of liq. potassæ, which softens if it does not dissolve this gelatine; as well as in the presence of longitudinal cavities apart from the thecæ, this lichen shows considerable affinities to the curious and anomalous genus *Gomphillus*. On the other hand the apothecia, in their external conformation and, more especially, in the fact that occasionally very short stipites are present, coated with granules, betray a manifest relationship to *Stereocaulon*, with which I have meanwhile united it. This relationship is brought out all the more through the variety of *St. condensatum*, Hffm., where the apothecia are found also sessile on mosses, and have at first sight much the aspect of those of a *Lecidea*.

During the current year I detected on Ben Lawers, Perthshire, a form of

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* Dated at Glasgow, 21st September, 1874.

this variety of *St. condensatum*, where the apothecia do not betray the slightest traces of stipites, and which, in the absence of intermediate states, I am strongly inclined to elevate to the rank of a species, more especially as the spores are shorter and thicker than any belonging to this species hitherto seen.

In *St. strictum*, Bab., as well as in one or two others, are seen spores, very much resembling those of the present lichen, although not more than half their length. The reactions by means of iodine on the hymeneal gelatine also correspond generally to those seen in species of the same genus.

The relationship of this lichen to *Bæomyces* is less obvious, and, but for Dr. Nylander's assertion, (Synop. p. 175) and a certain primâ facie resemblance, I would not have mentioned this genus as analogous, indeed in the light of the present plant I can assert, with considerable confidence, that *Gomphillus* has much stronger affinities to *Stereocaulon* than to *Bæomyces*.

In plants such as the present it is extremely foolish to dogmatize in the matter of classification, and we are taught the lesson that nature is not to be cramped and confined by any such well defined limits as our modern classifiers would fain lead us to believe.

Stereocaulon buchanani, Strn.

Thallus tenuis effusus, cinerascens vel cinereo-virescens, e gonidiis conglomeratis mediocribus et filamentis irregularibus, fere omnino constans; apothecia majuscula (latit. 1–2 millim.), sessilia vel elevato-sessilia, interdum conglomerata, fusca (junioribus pallidis et nonnihil turbinatis), convexa et immarginata, intus fuscescentia, textura tenaci cornea. *Sporæ* 8næ, in thecis cylindricis, longissimæ, filiformes, 40–50-septatæ, longit. 0·16–0·22 millim., crassit. circa 0·003–0·004 millim.; paraphyses haud distinctæ. Gelatina hymenialis iodo leviter cærulescens (apicibus thecarum intensius tinctis) dein rufescens.

Thallus thin granular cinerascent or cinereo-virescent effuse, composed almost entirely of conglomerated gonidia of a medium size and an irregular fibrous stroma; apothecia rather above average sessile or elevato-sessile fuscous, in a younger state much paler and then somewhat turbinate, convex and immarginate, fuscescent within and of a tenacious horny texture; spores 8, in cylindrical asci, very long and filiform, 40–50-septate, and measuring 0·16–0·22 by 0·003–0·004 of a millim., paraphyses not distinct. Hymeneal gelatine slightly cærulescent with iodine, the apices of the asci more deeply tinted, the whole assuming afterwards a rufescent tint.

Notes on Stereocaulon buchanani, *Stirton.*

By Charles Knight, F.R.C.S., F.L.S.

The valuable report of Dr. Stirton on Buchanan's plant has been brought

ISOETES ALPINUS Kirk.

STEREOCAULON BUCHANANI, Stirton.

under my notice while it was passing through the press. The following notes—with the analysis made some years since—will be found useful. The plant has been named by Dr. Nylander (in a letter) *Lecidea subglobosa.*

Dr. Stirton's notes follow pretty closely parts of Nylander's description of the genus *Gomphillus*, Nyl. There is, however, an essential difference in the structure of the thallus from that of the *Gomphillus*, which is overlooked by Dr. Stirton, but which is strongly in support of his view that the plant should be classified under the genus *Stereocaulon.* In Buchanan's lichen the thallus is made up of gonimia, as in *Stereocaulon*, instead of gonidia as in *Gomphillus.* Nylander's description of the genus *Gomphillus* would apply if "gonimia" was substituted for "gonidia," thus: "Thallus tenuissimus, e *gonimiis* [gonidiis] mediocribus sphericis elementisque filamentoso-irregularibus gelatinose conglutenatis constans." The paraphyses are indistinct only from their exquisite fineness and compactness; not, I think, from the "tenacious stiff gelatine which pervades the hymenium."

The filaments which bind the gonimia together are few and scattered. The spores are 0·160 millim. long, and 0·003 millim. broad.

PLATE XXV.—*Stereocaulon buchanani.* Fig. 1, Section of apothecium with portion of thallus. 2, Gonimia. 3, Gonimia, with filaments. 4, Spores.

ART. LV.—*On the Occurrence of* Hæmatococcus sanguineus *on the Wool of a dead Sheep.* By SWEN BERGGREN, Ph. D., Lund University. Communicated by JULIUS HAAST, Ph. D., F.R.S.

Plate XXIV.

[*Read before the Philosophical Institute of Canterbury, 2nd April,* 1874.]

THAT group amongst the Algæ, which was formerly included under the term *Protococcus,* contains several species, which by their occurrence together in enormous numbers suffuse with a characteristic colour the substance upon which they grow.

To this section of plants belongs the so-called "red snow," which consists of simple roundish microscopic red cells, by which the ice and snow of alpine and polar regions are coloured red; another species sometimes grows in swamps and canals imparting to the water a similar hue; while to another, luxuriating in certain portions of the ocean, the Red Sea owes its name.

There are also species which form a red covering upon mosses or rocks; others again grow upon vegetable products used by man, for instance, fruit and bread—an occurrence which has given rise to remarkable errors of even historical importance as to their origin and nature.

Similar Algæ appear also occasionally upon animal bodies. Thus I found

upon the wool of a dead sheep in the New Zealand Alps, in the neighbourhood of the West Coast road, a species which, as far as microscopic examination has hitherto shown, is *Hæmatococcus sanguineus*.

This plant, forming blood-red spots upon the wool, consists of globular cells, invisible to the naked eye. Viewed under the microscope, the globules exhibit a golden-yellow colour, whilst the fibres of the wool are scarlet-red. This colour without doubt is derived from the red pigment of the cells, which has been pressed out from some cause impregnating the fibres.

The portion of the wool which was not exposed directly to the light has a green appearance, and this colour is most probably of the same origin as the red.

An analogous example of the change of colours is furnished by the plant which forms the so-called "red snow" mentioned above. Whilst the contents of the cells in a certain stage of their development are purple red, they change to a green colour in another; and one of the Algæ which imparts to the surface of the water a blood-red appearance, exhibits this colour only when subjected to the direct rays of the sun; the higher the light, the more intense the colour appears. At other times the plant is green.

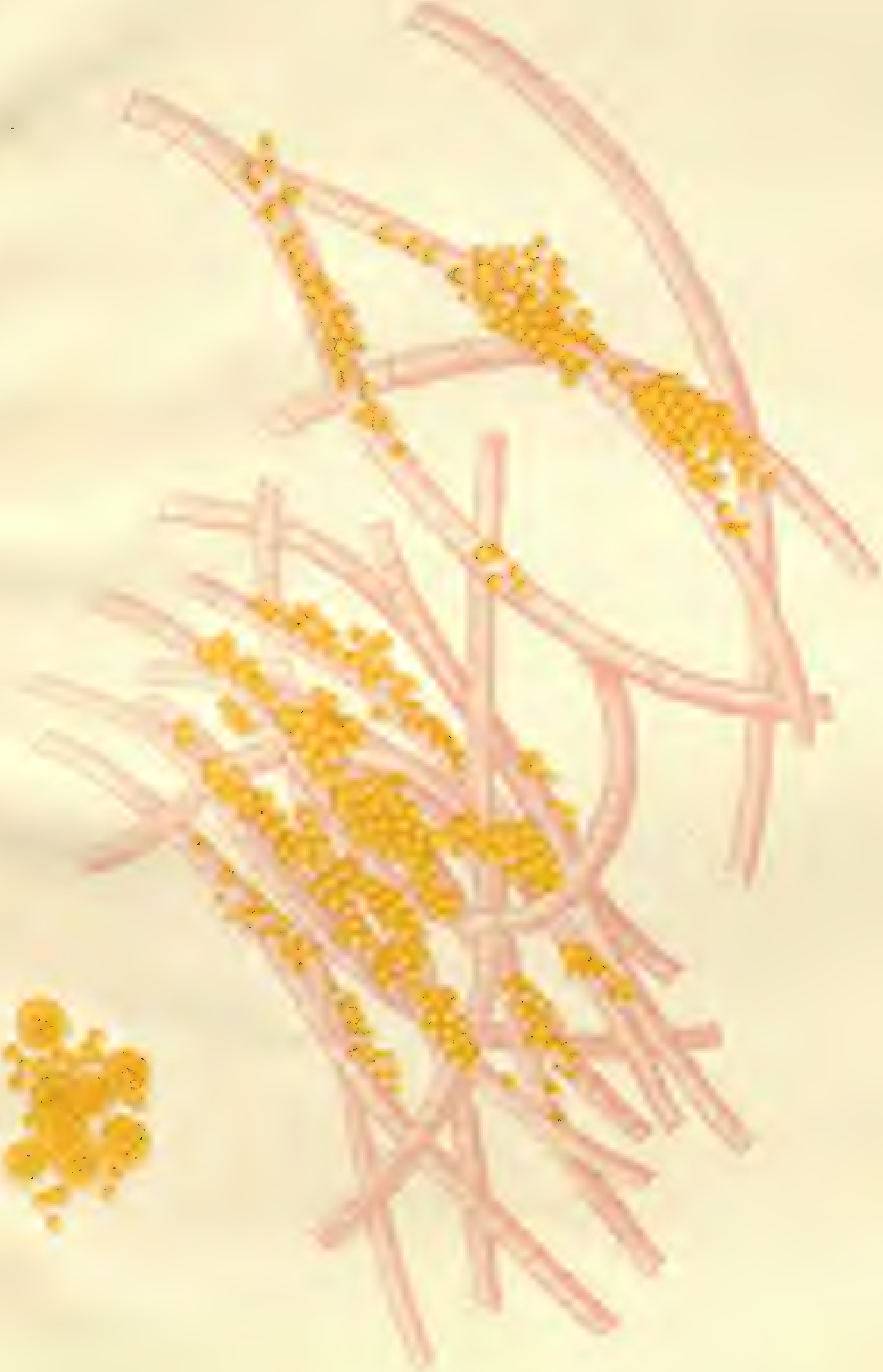
A specimen of wool (sent to the Canterbury Museum by Messrs. Studholme Brothers), showing a green-colour and taken from a living sheep, was shown to me by Dr. Haast, but this may be due to some infiltration of some mineral colour, although it has all the appearance of having been produced by a similar cause. It is true that all the fibres are uniformly coloured, but the Algæ originally growing amongst the wool may have been destroyed, leaving only the traces of their former existence in the fibres of the wool. It is desirable that further specimens presenting this uncommon appearance should be collected by persons having the opportunity of doing so.

Plate XXIV.—Fig. 1, Fibres of wool and Alga magnified. 2, Alga still more magnified.

Art. LVI.—*On some of the Naturalized Plants of Otago.* By G. M. Thomson.

[*Read before the Otago Institute, 7th April,* 1874.]

Mr. Kirk has recently called my attention to the fact that no list has yet been drawn up of the naturalized plants either of Dunedin or Otago. It is to be regretted that steps have not been taken, ere this, to watch and record the introduction of all foreign plants, as otherwise it becomes in course of time almost a matter of impossibility, on finding a plant of cosmopolitan distribution, to say, with any degree of certainty, whether it is indigenous or not. We have lately had experience of this difficulty, in the case of one of the commonest of weeds—*Polygonum aviculare*—which has given rise to so much discussion



between Messrs. Travers and Kirk. For the future the evil may be to a great extent avoided, by cataloguing all the non-indigenous plants hitherto collected, and constantly supplementing this record by the addition of every fresh discovery. It is quite unnecessary to point to the uncertainty which exists with regard to a large proportion of the British flora as to its origin. In this country there are some plants to which doubt may yet attach, as to the time of their introduction and the place from which they were originally carried.

Perhaps there is no method by which foreign plants are introduced in such quantity and variety as by the direct importation of agricultural and other seeds from Britain and other countries where there is much cultivated land. Every one conversant with rural matters in England or on the Continent, knows that, even where high cultivation is the rule, hundreds of species of weeds contest for possession of the soil, along with the legitimate crop of the husbandman. The meadows and pastures teem with their own peculiar weeds, and the seeds of these are certain to be present in greater or less quantity in all grass seeds collected. English seedsmen are in the habit also of purchasing largely from foreign importers, particularly heavy seeds, as clovers, timothy, rape, etc., so that seed brought to this country from any part of Britain is nearly sure to contain a great deal that is not bargained for, even when most carefully selected. By this means also, the weeds of Europe, America, India, etc., are distributed far and wide over our Colonial Empire, and, as is too often the case, to the serious detriment of the country which imports them. As a case in point, I may mention that, in 1869, a farmer in Southland imported from Messrs. Lawson and Sons of London and Edinburgh—a firm which has made the cultivation of grasses their speciality—a quantity of selected grass seed for laying down in permanent pasture. The assortment comprised twenty-one species of plants, but besides all that were included in the list making their appearance in due time, no less than thirty-seven species of weeds were found among them, including the clover-dodder (*Cuscuta trifolii*), and other comparatively rare plants.

In the Transactions of the N.Z. Institute, vol. II., p. 131, Mr. Kirk has drawn up a very elaborate series of divisions for the proper classification of naturalized plants. One of the most rapid agencies for the diffusion of such plants, and which affects horticultural as well as agricultural and accidentally introduced species, is that of floods. The Taieri plain furnishes a good example of this, plants from most diverse localities and introduced by totally different agencies, being there found in close proximity to each other.

In the accompanying list, I have to some extent followed the plan adopted by Mr. Kirk, using two or three similar contractions, and dividing them into similar series according to their method of introduction, viz :—

(*a.*) Horticultural. (Hor.) Escapes from, or remains of gardens.

(*b.*) Agricultural. (Agri.) Escapes from, or remains of field cultivation.

(*c.*) Accidentally. (Acc.) Introduced by animals, or unintentionally by man's agency.

(*d.*) Uncertain. (Unc.)

List of Naturalized Plants found in Otago.

Ranunculaceæ.

1. *Ranunculus acris*, (L.) Acc. } Common in rich pastures and cultivated bush land.
2. „ *repens*, (L.) Acc. }

Berberidaceæ.

3. *Berberis vulgaris*, (L.) Hor. Abandoned gardens in the Taieri Plain.

Papaveraceæ.

4. *Papaver rhœas*, (L.) Acc. In one or two spots in cultivated land, and near Dunedin in gardens.

Fumariaceæ.

5. *Fumaria officinalis*, (L.) Acc. In cultivated land.

Cruciferæ.

6. *Cheiranthus cheiri*, (L.) Hor. Escaped from gardens, and gone wild in a few dry and stony localities.
7. *Nasturtium officinale*, (R. Br.) Hor. or Acc. Possibly introduced as a salad plant, but now abundant in streams.
8. *Barbarea vulgaris*, (R. Br.) Acc. Certainly the introduced plant, now a common wayside weed.
9. *Brassica oleracea*, (L.) Agri. or Hor. On Otago Peninsula and Taieri Plain.
10. „ *rapa*, (L.) Hor. and Agri. } Establishing themselves as weeds in some cultivations.
11. „ *napus*, (L.) Agri. }
12. *Sinapis arvensis*, (L.) Acc. Fields and roadsides.
13. *Cochlearia armoracia*, (L.) Hor. Abandoned gardens.
14. *Lepidium campestre*, (R. Br.) Acc. Roadsides.

Resedaceæ.

15. *Reseda suffruticulosa*, (L.) Hor. As a weed in some gardens in Dunedin.

Violaceæ.

16. *Viola tricolor*, (L.) Acc. In arable lands.
17. „ „ var. *arvensis* (Murr.). Acc. In arable lands.

Caryophyllaceæ.

18. *Silene gallica*, (L.) Acc. or Hor. Abundant on the Forbury Head, Dunedin.
19. *Lychnis githago*, (Lam.) Acc. In arable and grass lands.
20. *Stellaria media*, (Wither.) Acc. Common weed.
21. *Cerastium glomeratum*, (Thiul.) Acc. In arable land and roadsides.

22. *Cerastium vulgatum*, (L.) Acc. Common weed.

Geraniaceæ.

23. *Geranium molle*, (L.) Acc. Roadsides, fields, and meadows.

Linaceæ.

24. *Linum usitatissimum*, (L.) Agri. Fields and waste ground.

Leguminosæ.

25. *Ulex europæus*, (L.) Agri. or Hor.
26. *Sarothamnus scoparisis*, (Koch.) Agri. or Hor.
} Selfsown from gardens and hedgerows. Have become a pest in some pastures.

27. *Medicago sativa* (L.) Agri. Occurs in pasture in Southland, but seems to make no progress.
28. *Medicago lupulina*, (L.) Agri. Meadows.
29. *Trifolium pratense*, (L.) Agri. ,,
30. ,, *medium*, (L.) Agri. ,, increasing fast.
31. ,, *repens*, (L.) Agri. In pastures, and in fact everywhere from sea-level to 1,500 feet.
32. *Trifolium minus*, (Sm.) Agri. Very abundant in pasture, etc.
33. *Lotus corniculatus*, (L.) Agri. In pastures.
34. ,, *major*, (Scop.) Agri. Pasture in Southland.
36. *Anthyllis vulneraria*, (L.) Acc. Introduced with grass seeds into Southland.
37. *Vicia tetrasperma*, (Mœnch.) Acc. Fields and roadsides.
38. ,, *sativa*, (L.) Agri. or Acc. Fields and pastures.
39. *Onobrychis sativa*, (Lam.) Agri. Fields and meadows, but does not increase.

Rosaceæ.

40. *Fragaria vesca*, (L.) Hor. Woods, banks, and pastures.
41. *Rubus idæus*, (L.) Hor. Old gardens.
42. ,, *fruticosus* (?.) Hor.
43. *Rosa rubiginosa*, (L.) Hor.
44. ,, *canina*, (L.) Hor.
} Roadsides, etc.

Grossulariaceæ.

45. *Ribes grossularia*, (L.) Hor. Old gardens and in bush.

Umbelliferæ.

46. *Apium graveolens*, (L.) Hor.
47. *Pitroselinum sativum*, (L.) Hor.
48. *Pastinaca sativa*, (L.) Hor.
49. *Daucus carota*, (L.) Hor.
} Escapes from gardens.

Caprifoliaceæ.

50. *Sambucus nigra*, (L.) Hor. In a few spots in bush.

Rubiaceæ.

51. *Sherardia arvensis*, (L.) Acc. Pastures, arable land and roadsides.

Dipsacaceæ.

52. *Knautia arvensis*, (Coult.) Acc. In a meadow at Roslyn, Dunedin.

Compositæ.

53. *Bellis perennis*, (L.) Acc. Pastures.
54. *Achillæa millefolium*, (L.) Acc. Pastures in Taieri Plain.
55. *Anthemis nobilis*, (L.) Hor. Meadows and roadsides.
56. *Matricaria parthenium*, (L.) Hor. Meadows.
57. *Chrysanthemum leucanthemum*, (L.) Acc. Pastures.
58. " *segetum*, (L.) Acc. "
59. *Artemisia absinthium*, (L.) Hor. Spreading from gardens with great rapidity.
60. *Senecio vulgaris*, (L.) Acc. Fields, waysides, etc.
61. *Centaurea cyanus*, (L.) Acc. Fields in Taieri Plain.
62. *Carduus lanceolatus*, (L.) Acc. Abundant everywhere.
63. *Chichorium intybus*, (L.) Hor. Fields on the Taieri.
64. *Taraxacum dens-leonis*, (Desf.) Acc. Fields and waysides.
65. *Sonchus oleraceus*, (L.) } Acc. Abundant weeds.
66. " *asper*, (Hoffm.) } Acc. Abundant weeds.
67. " *arvensis*, (L.) Acc. Cultivated land.
68. *Crepis virens*, (L.) Acc. Fields and roadsides.

Convolvulaceæ.

69. *Cuscuta trifolii*, (Bab.) Acc. Introduced into Southland from Britain with clover seed in 1869.

Boraginaceæ.

70. *Echium vulgare*, (L.) Acc. In meadow in Southland.
71. *Lithospermum arvense*, (L.) Acc. Fields and roadsides in Taieri Plain.

Scrophulariaceæ.

72. *Digitalis purpurea*, (L.) Hor. Escaped into the bush in many localities.
73. *Linaria purpurea*, (Mill.) Hor. Near Dunedin.
74. *Rhinanthus crista-galli*, (L.) Acc. In meadows.
75. *Veronica chamædrys*, (L.) Acc. Pastures in Taieri Plain.
76. " *serpyllifolia*, (L.) Acc. Pastures and waste ground.

Labiatæ.

77. *Mentha viridis*, (L.) Hor. Abundant on banks of streams.
78. *Ajuga reptans*, (L.) Acc. Covering great parts of the town-belt round Dunedin.

Primulaceæ.

79. *Primula vulgaris*, (L.) Hor. In neighbourhood of gardens.

80. *Anagallis arvensis*, (L.) Acc. Dry open banks and roadsides.

Plantaginaceæ.

81. *Plantago lanceolata*, (L.) Acc.
82. „ *media*, (L.) Acc.
83. „ *major*, (L.) Acc.

} These ribworts are all found as meadow and wayside weeds, often associated together.

Polygonaceæ.

84. *Rumex crispus*, (L.) Acc. An exceedingly abundant weed.

85. „ *acetosella*, (L.) Acc. Abundant everywhere, and most difficult of eradication.

86. *Polygonum aviculare*, (L.) Acc. Indigenous or introduced. An exceedingly common weed.

87. „ *convolvulus*, (L.) Acc. A weed in many gardens in Dunedin.

Euphorbiaceæ.

88. *Euphorbia peplus*, (L.) Acc. A garden weed; common.

89. „ *lathyris*, (L.) Acc. or Hor. Only seen in the neighbourhood of Dunedin, where it occurs as a garden weed.

Urticaceæ.

90. *Urtica urens*, (L.) Acc. or Unc. Some small patches occur in the Valley of the Leith, and appear to be increasing, though not so fast as might be expected.

Gramineæ.

91. *Anthoxanthum odoratum*, (L.) Agri.
92. *Phleum pratense*, (L.) Agri.
93. *Alopecurus pratensis*, (L.) Agri.

} All introduced as pasture grasses.

94. *Holcus lanatus*, (L.) Acc.
95. „ *mollis*, (L.) Acc.

} Very abundant in fields, swamps, roadsides, etc.

96. *Poa annua*, (L.) Acc. Indigenous or introduced.

97. „ *pratensis*, (L.) Agri. Meadows in Southland.

98. *Briza media*, (L.) Acc. or Hor. Waysides about Dunedin.

99. *Dactylis glomerata*, (L.) Agri. Meadows and pastures.

100. *Festuca ovina*, (L.) Agri.
101. „ „ var. *duriuscula*, (L.) Agri
102. „ *pratensis*, (Huds.) Agri.
103. „ „ var. *elatior*, (Koch.) Agri.

} Introduced as pasture grasses.

104. *Serrafalcus mollis*, (Parl.) Acc. In meadows and roadsides.

105. *Lolium perenne*, (L.) Agri.
106. „ *italicum*, (A. Braun.) Agri.

} Introduced as pasture grasses.

The foregoing comprise all the naturalized plants as yet collected by me. There are still, however, a great many introduced grasses, and I have never examined the littoral and aquatic floras, so that no doubt the above list would

require to be doubled or trebled to represent adequately the number of non-indigenous plants. I hope that this small contribution may be the means of inciting other members of the Institute and Field Club to make known any plants which they have discovered, and which are not mentioned by me.

Art. LVII.—*On Mottled Kauri.* By James Stewart, C.E.

[*Read before the Auckland Institute, 26th August,* 1874.]

Regarding the origin of the rich mottled shading of some kauri trees, considerable diversity of opinion exists, some ascribing it to a timber disease, while others believe such trees to belong to a variety of the kauri. The slightest examination, however, seems to show that this is no variety, but a peculiarity due to an abnormal growth in the sap-wood and bark. The mottled kauri is rather a rare tree, but a young mottled kauri is rarer still.

If it were a variety we should expect to find the markings in the roots and stumps; on the contrary, it is believed those parts are never affected, and for some distance up the trunk the timber is often just like that of other kauri. Allowing then, that it is to an abnormal state of the growth of the tree we owe this rich and valuable furniture wood, an enquiry as to the operating cause may not be uninteresting.

On examining a portion of the outer timber and bark of a highly mottled tree such as the specimens now exhibited were cut from, we see the bark entangled in the sap-wood, being pitted and streaked in some places very deeply. The specimens are all sawn from a board showing bark and sap-wood, and little or no heart timber. The bark has mostly fallen away during the seasoning, but the action and growth of the mottling are very clearly shown by examining the sections across grain. The bark is shown to become entangled in the ligneous growth, and has been surrounded and retained, sometimes in cells, sometimes leaving only a trace of non-fibrous barky matter in thin flakes, causing shaded parts, broad or narrow, according as the timber is cut relative to their planes. Nearest the bark the mottlings are nearly pure bark, and as they are found in the tree away from the surface, they are observed to be more and more of a ligneous structure. A close study of the specimens will convey an impression of the connection between the bark and the markings, better than any written description can do, but it is to be observed that all around this, in some degree foreign substance, the true wood is shaded and marked in itself, just as it is to be observed in knotty timber, and as the timber is transformed to the state of heartwood, a deposit of gummy and ligneous matter seems to transform even the largest of the imprisoned flakes into veritable woody fibre.

Any abnormal state of growth seems not to affect the health of the tree, as mottled kauri trees are often the largest and soundest. The beauty of this timber and its effect in furniture are often marred by injudicious selection. Not only do trees vary in their mottled character, but by judicious sawing a great variety can be obtained from one tree, and nothing has a worse appearance in furniture—however well made—than an indiscriminate loading of mouldings, framing, pilaster, and panels, with rich and heavy mottled kauri.

ART. LVIII.—*Description of a new Species of* Isoëtes.—By T. KIRK, F.L.S.
Plate XXV.

[*Read before the Wellington Philosophical Society, 29th August*, 1874.]

THE genus *Isoëtes* has been added to the New Zealand flora since the publication of the Handbook, the first species having been discovered in the Waikato Lakes by Captain F. W. Hutton and myself in 1869. The plant which forms the subject of the present notice was discovered by Captain Hutton and Mr. W. T. L. Travers three years later in Lake Guyon, Nelson, at an altitude of 3,000 feet. I am indebted to Mr. Travers for specimens.

Not having the opportunity of referring to the recently described austral species of this genus, I can only venture to offer a brief diagnosis under the provisional name of *I. alpinus*, and indicate its chief points of difference from the lowland species, *I. kirkii*, Braun.

Isoëtes alpinus, n.s.

Fronds numerous, ten to fifty or more, stout, rigid 4″ — 6″ long; phyllopodes extremely dilated, with the border produced for some distance along the edge of the frond; sporangium broadly elliptic, 4-septate; ligule minute, triangular; macrospores globose, perfectly smooth, except the faint tricrural line; microspores ovate, closely tuberculated, faintly angled, longitudinal furrow obscure.

Hab.—Lake Guyon, Nelson, alt. 3,000 feet—Messrs. Hutton and Travers; Lake Pearson, Canterbury, if I am correct in identifying a very imperfect specimen collected by Dr. Berggren with the present plant.

Solitary specimens of *Isoëtes alpinus* often exhibit from sixty to seventy crowded fronds, radiating in a circle of from six to seven inches diameter. The central vascular portion of the frond is also largely developed.

Our plant is readily distinguished from *I. kirkii* by its robust habit and larger size: and especially by the smooth macrospores and tuberculated microspores.

PLATE XXV.—*Isoëtes alpinus*, nat. size.—Fig. 5, Phyllopodium containing macrospores. 6, Sporangium. 7, Transverse section of ditto. 8, Macrospores. 9, Microspores.

Art. LIX.—*On the Occurrence of* Juncus lamprocarpus, *Ehr., in New Zealand.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 29th August,* 1874.]

In the early part of the present year I discovered *Juncus lamprocarpus*, Ehr., growing in great abundance about Karori and other places in the vicinity of Wellington; and a few months later in the southern part of the province of Otago. About Wellington it occurs only in wet, swampy places, where it often forms a large portion of the herbage and is closely cropped by cattle; at Invercargill it is found not only in swamps, but in places where the soil is scarcely moist, even on the railroad track, a peculiarity which is possibly due to the greater amount of moisture in the atmosphere at the latter place.

Juncus lamprocarpus is allied to *J. holoschœnus*, Br., which it resembles in the jointed and compressed stems and leaves, but from which it differs in the much branched panicle, in the segments of the perianth being shorter than the capsule, and especially in the fascicles never being collected into lateral cymes.

When compared with British specimens, the New Zealand plant is seen to have the internal divisions of the leaf and stem more prominent, while both the inner and outer segments of the perianth are acute and much shorter in relation to the capsule.

Our plant may be expected to prove of not unfrequent occurrence in the South Island, although probably confined to the province of Wellington in the North.

The avidity with which it is eaten by cattle is doubtless one cause of its having been so long overlooked in this district.

IV.—CHEMISTRY.

Art. LX.—*On the Analogy of Cyanogen to Oxygen.* By William Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 29th August,* 1874.]

I have to preface my remarks upon this subject by the statement that they are entirely of a theoretical nature, and therefore unsupported by the results of that kind of experimental research, the details of which it will be remembered have hitherto constantly formed the groundwork of those previous papers of mine read before you; however, for this once I must beg your kind indulgence for a hearing upon that which, if it has any value, owes it to chemical researches and chemical records, long since accumulated by other chemists.

Presuming then upon your indulgence, I will at once state that the subject of this paper is the true position of a certain compound body among the elements as deducible from its known chemical reactions, that now assigned to it being, I think, incorrect.

The great impoitance of interpreting those facts correctly by which we compare our imitative with our real elements, is so obvious to those anxious to apprehend more of the true nature of the elements than at present we do, that I need not excuse myself for bringing such a matter as this before you.

The substance, the supposed position of which I take exception to, is cyanogen, a compound as you are aware of carbon and nitrogen in equivalent quantities. It and a number of other compounds into which it enters are now classed indiscriminately and collectively with the chlorine group as salt radicals, but to cyanogen itself "par excellence" is attributed this character.

That this is in reality the position assigned to cyanogen is indisputable. Brand and Taylor in their excellent work on chemistry, designate this substance as a compound radical and associate it with chlorine, bromine, and iodine for reasons I shall presently show. Prof. Roscoe too in his Elementary Chemistry, 1871, describes cyanogen in terms which certainly have a tendency to keep it so classified. The special grounds upon which cyanogen is classed with these radicals are, I believe, as follows:—

1st. That it and its hydride combine directly with the least oxidizable metals generally, as gold and silver.

2nd. That it also combines with hydrogen and forms with it a compound analogous to hydrochloric acid.

3rd. That when passed into a solution of any caustic alkali it is in part oxidized, alkaline cyanates and cyanides forming.

4th. That when cyanides are electrolyzed the radical is evolved at the positive pole.

If to this we add that cyanide of potassium crystallizes in cubes, as do the chlorides, bromides, and iodides of this base, I think we exhaust the evidence which can as yet be alleged in favour of the analogy of cyanogen to the elements referred to.

Such are the reasons for classifying cyanogen with these radicals, and I will now go over them seriatim.

In the first place it is true that cyanogen combines directly with the least oxidizable metals, but so does oxygen when in the allotropic state, also sulphur at a slight elevation of temperature, and further its hydride (sulphuretted hydrogen) imitates hydrocyanic acid in presence of the metals instanced; oxygen and sulphur should therefore on this principle be admitted along with cyanogen into the group of radicals, which would be absurd, as they are not admitted as radicals at all. Therefore these tests are unreliable.

In the second place, besides cyanogen, sulphur and a number of other elements combine readily with hydrogen, the bulk of which are not halogens, while in reference to the supposed analogy existing between hydrocyanic and hydrochloric acids, I really fail to see any grounds for this.

Hydrochloric acid is a very strong one, intensely acid, and forms salts with the alkaline metals which are quite neutral. Hydrocyanic acid on the other hand, if acid at all (which I doubt), is so feebly so that "it scarcely affects the blue litmus paper"; indeed I believe it to be neutral, as any minute acid reaction which has been obtained in respect to it may be due to carbonic acid, hydrocyanic acid being very prone to decompose with evolution of carbonic acid.

Further, in accord with this, the salts of cyanogen with the alkaline metals are not neutral, as are the corresponding salts of the chlorine group, but strongly alkaline.

In reference now to the third supposed joint characteristic of cyanogen and the radicals to which it is compared, we can parallel this in the case of sulphur and phosphorus; thus either of these elements, when warmed with a solution of any caustic alkali, forms oxygenated and haloidal salts, a part of them being oxidized at the expense of the oxygen of the alkali, as in the case of cyanogen, chlorine, etc., under these circumstances.

Lastly, as to the polar affinities of cyanogen and the crystalline form of its potassium salt. Sulphur and oxygen when liberated by voltaic action also

detach from the negative pole; while in reference to the similarity in the crystalline forms of cyanide of potassium to the chloride, so many substances crystallize in the same form, though these are of a widely different nature, that, as a single test of position, form can be of little value.

Thus I think the grounds upon which we class cyanogen in this manner do not when carefully examined prove at all sound, but it rather appears, if admission to the group of halogens is given to cyanogen, that we must upon principle further admit within it substances, such as sulphur and oxygen, which obviously should not enter there.

But, outside anything yet stated, it is indisputable that the heavy metallic cyanides do not correspond in general with the chlorides, bromides, etc., of this series of metals; except in the case of the silver salts, there is no appearance even of harmony in this direction.

Again, the most stable oxygen compound of cyanogen is, according to the new chemical notation, Cy O, while that of chlorine is $Cl^2 O^5$, of bromine $Br^2 O^5$, etc; further Cy O (cyanic acid) forms compounds with the metals which are generally insoluble in water, alcohol, or ether; while chloric acid, its alleged analogue, generally forms compounds with them, possessing considerable solubility in these liquids. There is in fact as great a difference between the two acids and their metallic compounds on these points as there is between carbonic and nitric acid and between their respective metallic compounds; further, the composition of platino-chloride of potassium is $K + Pt + Cl_4$, while that of the platino-cyanide is $K^4 + Pt^2 + Cy^{10}$, exhibiting again a marked difference.

The great dissimilarity existing between cyanogen and the elements of the chlorine group, analogically considered, being thus shown, and the ground I hope consequently ready for the reception of a better classification than the one attacked, I now proceed to show what I conceive to be the proper position of cyanogen in regard to the elements. For this purpose I will refer you to the supposed points of resemblance between this substance and chlorine, which I have just criticised, and I think you will find that, wherever the true character of cyanogen is correctly stated, it agrees precisely with that of oxygen.

Thus, to recapitulate a little, oxygen, especially when in the allotropic form, combines directly with metals generally, including gold and silver, moreover it combines with hydrogen to form a neutral compound, and this when electrolyzed delivers its oxygen at the positive pole. Besides this cyanogen resembles oxygen, wherein, as shown, it differs from the chlorine group, its compound with the alkaline metals being caustic, and those with the heavy metals characterized by great insolubility in water, while several of these cyanides are soluble in alkaline cyanides, precisely as several of the

metallic oxides are soluble in alkaline oxides; further, cyanogen, like oxygen, is capable of assuming an allotropic condition.

Following up analogies here, I would class cyanogen and sulphur together, and so I would their hydrides. HS, like cyanogen, is not strongly acid, indeed probably not acid at all, for as in the case of hydrocyanic acid HS exhibits a great tendency to oxidize when in contact with water and to form oxyacids, so that in testing this gas for acidity we are liable to obtain reactions not due to the gas itself.

Our new nomenclature, by doubling the equivalents of oxygen and sulphur, has disturbed the uniformity which before this existed between their common hydrides and that of cyanogen; thus one point of resemblance has been removed, but I think this has been done somewhat arbitrarily in regard to cyanogen. Certainly when the equivalent of cyanogen is retained, its hydride then being Cy H (hydrocyanic acid), comparing with that of chlorine, the supposed similarity of these substances is maintained; and this by the way may have been one of the reasons for which the doubling process described was broken off at cyanogen. However, if I am correct in assuming that this compound is analogous with oxygen rather than with chlorine, its equivalent will also require doubling. If you now agree with me, or at least will contemplate the possibility that cyanogen is not analogous to chlorine and its isomorphs, but rather to oxygen, you will be in a position to perceive certain interesting relations which it bears to oxygen, and which could not well have presented themselves had the assumption I have here attempted to disprove remained unassailed.

Thus ferro- and ferri-cyanogen become upon this view ferri-oxides in which oxygen is replaced by its isomer cyanogen, and the same being true for the rest of the metallic cyanides, these substances should be, I think, viewed as comparing with the oxides of sulphur and chromium as they exist in the sulphates or chromates; further, sulphocyanogen and selenocyanogen, the only compounds containing cyanogen (or at least its elements), which do compare with the simple halogens, are not at all analogous with cyanogen. The cyanides thus viewed are not salts at all any more than the oxides are; sulphocyanides on the other hand are true salts, comparing exactly with the corresponding salts of the halogens.

Further, in regard to the question often raised as to the nature of certain of our elements, whether compound or not, it seems interesting that in this compound, cyanogen, we have a substance very similar to the element oxygen, one which at least only varies from it within the limits we are compelled to allow for *variation* in the members of certain well defined natural groups of our elements. We are thus, as far as is allowable from such apparent resemblances, justified in entertaining the supposition that oxygen itself is

also a compound body. I need not remind you in this connection that any theory which touches upon the nature of this gas has now an especial interest to us, for as you will be aware this and our most common gases or gaseous vapours are, for good reasons, considered to be distributed throughout the earths and suns generally,* and even to pervade the spaces between them and to perform all the functions we have hitherto allotted to a purely hypothetical substance. The nature therefore of any gas which is possibly a constituent of that which we now consider to be a universal atmosphere, becomes invested with an importance to us far beyond what we could even conceive of a short time since.

Lastly, in regard to the question as to the nature of our elements, it appears a very noteworthy circumstance that, by combining cyanogen with sulphur, which is also an analogue of oxygen, we obtain a compound analogous to the halogens I have referred to. That this ternary compound sulphocyanogen should be thus a true salt-radical, is strongly favourable to the idea that one or more of the chlorine group of elements is of a compound nature, and in relation to this it is worthy of record that, as I have already pointed out, the "equivalent number of sulphycyanogen is one which is very nearly the mean between that of chlorine and bromine."

However, whether these facts indicate anything of this kind or not, I think the object of this paper has been fulfilled, for I believe I have shown that, to use a familiar but significant phrase, cyanogen has not the "stuff" in it for making a salt-radical singlehanded, therefore it is not in any way analogous to one, but in order to make it so we must combine it with another element, so that three elements in place of two are as yet the smallest number required to form a compound salt-radical.

In concluding my paper, I cannot avoid expressing a wish that the question which I have raised here had been taken up by some one more accustomed, by training and association, than myself, to grapple it by the aid of what is well termed the "New Chemistry." I have worked at this question by the old lights; but if by this I am successful in inducing any one to take it up who will work at it by the new ones, I shall be satisfied with the result.

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* Fuel of the Sun, by W. Mattieu Williams, F.C.S.

ART. LXI.—*On the Evolution of Heat during the Hydration of Clay-slate, Clay, and Coal.* By WILLIAM SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 29th August,* 1874.]

HAVING announced, in November, 1871,* that clay-slate hydrates when in contact with water, as shown by the coagulation test devised by me, I have been desirous to obtain corroborative evidence in support of this statement, and so prosecuted the matter further; and being under the impression that the hydration of this substance would evolve heat, I ground some clay-slate to a very fine powder and put it in a small quantity of distilled water, when an elevation of temperature occurred in the mixture equal to about 2° F. above the temperature of the materials used.

To make sure that none of this rise was due to heat generated during the act of crushing, and retained in such a manner that the exact temperature of the powdered substance could not be ascertained, I repeated the experiment, but with this variation—the crushed slate was bottled off and not used till twenty-four hours afterwards. The thermometric results were the same.

The water after the mixing was slightly alkaline, owing no doubt to the presence of a minute quantity of alkalies derived from the slate, to the hydration of which or their compounds a part of the elevation of temperature noticed might have been due. To obtain, therefore, some indication of the quantity of this, I crushed some glass to quite as fine a powder as I had the slate instanced, allowed it twenty-four hours to cool (as I may state here I have for all succeeding experiments upon substances dried by heat), and then mixed it with water in same proportions as observed for the slate, when an elevation of temperature barely equal to 1° F. occurred. The water was of course strongly alkaline directly after the mixing; clearly, therefore, the alkalies of the slate had no important share in producing the elevation of temperature observed.

At this stage I struck aside a little to experiment upon coal, clay, and other substances, in the hope of obtaining facts extending over a wider field, and so capable of being handled more correctly and with greater ease, and I found carbonate of lime, as also quartz and brown coal or clay, did not give any indication of an evolution of heat when mixed with water; steatite, however, and anhydrous coal, also hydrous coal, clay, and lignin, when dried gently or wholly, did so. Steatite had as much heating power as slate, while all the remaining substances cited were superior to it in this respect. In the case of naturally anhydrous coal, or hydrous coal and clay dried at from 90° to 212°, or over desiccating substances (at common temperatures), I frequently obtained a rise of temperature from 3° to 6° F.

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* Proceedings of New Zealand Institute, vol. iv., p. 381.

These results tend to show that, as a general rule, any so-termed hygroscopic substances, when deprived of even the smallest portion of their water, and then allowed to regain this, generate heat in doing so. It will at once appear that, if in place of submitting water to these dried substances we submit aqueous vapour, the evolution of heat would be much greater, and in fact I find that these substances desiccated and exposed to common air rise in temperature very notably.

It only remains now to consider how much of this elevation of temperature is due to mechanical, and how much to chemical agency.

It is obvious a portion of this is due to friction, occasioned by the rapid inrush of water to the pores of these substances. I believe the calorific effect of such inrushes has not yet been measured, if indeed noticed, before, and in all likelihood they will be deemed so small as to be barely perceptible, or at most not at all necessary to take into account in determining the origin of the increase of temperature instanced ; but as I felt anxious to get the approximate calorific result due to chemical agency, I have made an attempt to effect this by comparative tests.

In this attempt I substituted other liquids for water, liquids which, experimentally, I found had no action upon the solids used, or only to a very minute extent.

My results were as follows :—

I. Clay-slate mixed with water raised a thermometer placed in the mixture 2° F. above the temperature of these substances, at the time of mixing them. A portion of the same sample of clay-slate, and in quantity as before, mixed with pure kerosene in same volume as that of the water used, only raised the thermometer $1\frac{1}{4}$° F.

II. Dried brown coal, similarly treated, gave an elevation of temperature equal to 4° F. with water, and only 2° F. with oil. The same conditions were observed as to quantities and volumes as in the first experiment.

As the kerosene used would have a less specific heat than water, the amount of heat due to friction in the first experiment would not be *so much as* $1\frac{1}{4}$°, and in the second experiment not *so much as* 2°, leaving a balance of heat equal to something more than $\frac{3}{4}$° and 2° F. for the slate and coal respectively, which balance is, I conclude, due to chemical action ; and as I believe kerosene is more diffusive than water, and so would rush these substances with greater rapidity than water would, thus producing more friction, the balance of heat found is, perhaps on this account, again less than the actual amount due to chemical action.

Returning now to the subject I started with, the supposed direct hydration of clay-slate by water, and bringing the results just stated to bear upon this question, it certainly appears that this substance evolves heat when mixed

with water, which heat is the result of *chemical action*, and the only agency to which I can attribute this chemical action is hydration.

Thus the statement hazarded as to the direct hydration of clay-slate by water receives support upon the ground I have just traversed.

Applying now the facts just elicited in a general manner, it appears—

(1.) That in the disintegration of rocks or soils heat is evolved.

(2.) That the differences in temperature sometimes observed between contiguous strata may be due, wholly or partly, to this cause.

(3.) That our native anhydrous coals hydrate upon their surfaces when exposed to water or aqueous vapour.

(4.) That hygroscopic water is chemically-combined water.

(5.) That the quantity of water present in certain rocks or minerals may, when known, frequently indicate the highest temperature to which they have been subjected.

(6.) That vegetable matter (leaves, twigs, etc.) generally developes heat by hydration; also by friction, when the temperature of the air surrounding it is lowered.

In regard to these statements it requires, in the case of (3), gravimetrical experiments to support it, which I shall presently endeavour to obtain, and if they should prove it a correct one, that is, that anhydrous coal can hydrate, and to any notable extent, it will certainly appear that this substance has been formed at a somewhat elevated temperature, perhaps approaching to nearly 100° C.

While upon the subject of the formation of coal, I would just like to observe here, that I cannot avoid thinking the effects of pressure in consolidating this, and indeed other minerals, also rocks, are considered much greater than they really have been, and this because it seems that these substances will generally, if not always, be charged with water, oil, or gas, and, if this is so, I conceive the consolidating action of pressure would be very greatly mitigated, and would be in some proportion to its actual volumetrical effect upon the liquid receiving it. I cannot see how particles suspended in, or throughly soaked with a liquid, can be made to approach each other by pressure, except by allowing the liquid to escape, and it does not appear, in the case of rocks, etc., at some depth, that there can be any such way of escape, at least a sufficiently ready one, for the liquids or gases lodged in their pores.

In reference to the statement (4) that the hygroscopic water of substances retaining it is combined water, this appears certain from what has been described, and also from other considerations. Thus, to take an analogous case, the salt chloride of silver forms a definite crystallizable chemical compound with ammonia, but, though acknowledged as such, it can only be preserved in an atmosphere of ammonia, and if this gas is taken away as

evolved, the mineral loses the whole of it, even at common temperatures. Now, I conceive water has relations to the so-termed hygroscopic substances, similar to those ammonia sustains to argentic chloride; it chemically combines with these substances, and the compounds thus formed are not permanent, except, at a temperature not higher, and a tension of aqueous vapour not less, than that at which they were produced.

Lastly, as to a production of heat by the chemical combination of water with the substances of plants, a combination brought about by changes in the temperature of the air, or in the tension of its vapour, this is no doubt a very useful provision for preventing atmospheric changes of this nature affecting the vegetable world abruptly.*

ART. LXII.—*Notes on the Formation and Constitution of Torbanite and similar Minerals.* By WILLIAM SKEY, Analyist to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 29th August,* 1874.]

IN prosecuting experiments, previously detailed, upon the evolution of heat caused by mixing dry clay with various liquids, I noticed such an increase of temperature in the case of petroleum that I suspected an absorption of a portion of the matters dissolved in this liquid had occurred, and so was led to investigate the matter further, when the following results were obtained:—

(1.) That our commercial kerosenes are nearly or quite decolorised by mixing them with dry clay, and our best native petroleum greatly modified.

(2.) That this process is very much quicker when the clay used has been dried at 100° or so C.

(3.) That in such a case the clay, if white, acquires a rose and afterwards a black colour, while its streak is light brown.

(4.) That torbanite has the same effect as clay.

(5.) That the coals I have examined, whether hydrous or anhydrous, do not appear to exercise any absorbent action upon the petroleum oils.

(6.) That the same is true of diatomaceous earth (dry), carbonate of lime, and gypsum, hydrous or anhydrous, also pumice-stone and pipe-clay (ignited).

(7.) That kerosene which has been completely decolorised by clay, when heated to 100° to 150° C., blackens clay, but has no such effect upon other porous substances, as gypsum, or prepared silica.

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* As I have since ascertained that heat is also evolved during the hydration of anhydrous wool, it is probable that we have in this a provision of the same nature for use in the animal world too.—W. S., 23rd April, 1875.

(8.) That clay is similarly affected by hot paraffin.

(9.) That clay can readily be charged with some of the constituents of petroleum, to such an extent as to have almost the consistence as well as the appearance of torbanite.

These results have, I believe, an important bearing upon our present theories as to the formation and constitution of the valuable mineral torbanite. As to the formation of this mineral, it plainly appears from them that clay strata can abstract the colouring matter of petroleum. If this process is carried on to a small extent we have only a feebly bituminous clay, but if carried on till the clay is saturated, or nearly so, we have a mineral which I believe has exactly the constitution of torbanite. During the formation of this mineral the petroleum passing through it would be purified to a greater or lesser extent.

From what has been already stated, I feel sure the absorption is not of a mechanical but of a chemical nature, and this brings me to the next point, that is, the nature of the mineral in question, torbanite or bog-head coal.

As to its constitution, this mineral is associated with the amber group in our best mineralogical works, and the earthy matter is thrown out of the formula. Now, this earthy matter is within small limits uniform in amount in the case of all the samples of this mineral yet analysed, being from nineteen to twenty-six per cent., and it is essentially silicate of alumina, that is anhydrous clay.

I consider, therefore, the ash of this mineral is not an accidental element as now stated, but is an essential part of it,—that, in fact, torbanite is a combination of a bituminous kind of substance with clay, the water of the clay being either substituted by it or a bitumino-silicate of alumina formed, which substance may have no affinity or but a very slight one for water.

The colouring matters for petroleum and kerosene are in general terms described as of a bituminous nature—bnt whether bitumen itself is actually or universally present in them has not yet been demonstrated. However, these colouring matters are certainly oxidized hydrocarbons, and so class with bitumen and the combustible part of torbanite.

Being thus oxidized hydrocarbons they can hardly fail to be of an acidic nature, and so the statement as to their capability to chemically combine with clays as shown, is one which a consideration of the basic nature of clay will, I think, greatly predispose us to admit as a correct one.

In conclusion, these results tend to indicate—

(1.) A cheap and expeditious method for purifying our coloured kerosenes, one in which there need hardly be any waste.

(2.) That by using pure clay useful pigments may perhaps be obtained in this manner.

(3.) That torbanite is *not coal*, but a chemical combination of an acid hydrocarbon with silicate of alumina.

(In this assumption I accept for the present the popular opinion which maintains the ash of coal itself to be an *accidental* element.)

(4.) That our present formula for torbanite requires amendment so as to include earthy matters.

I will only add that, judging from the basic nature of alumina and the refusal of silica in any form to combine to a notable extent with any of the constituents of petroleum, it appears most likely it is the alumina of the earthy matters of torbanite to which the retention of its combustible part is due. This matter, and the possibility or otherwise of substituting compounds of tin, iron, copper, etc., for that of alumina as absorbents of the substances named, is now engaging my attention, and so I trust to be able to give information upon these points at an early date.

ART. LXIII.—*On the Evolution of absorbed Sulphur from Carbon by Voltaic Action; with Notes upon the Rev. H. Highton's Theory for explaining the Evolution of this Gas from certain Batteries in Work.* By WILLIAM SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 21st November,* 1874.]

IN a paper read before this Society in 1870 upon the "Electromotive Power of Metallic Sulphides,"* I stated that graphite freshly prepared is negative to sulphurized graphite, and I observed that during the time sulphurized graphite is connected with zinc it evolves sulphuretted hydrogen. But viewing this phenomenon as only one of a series I had already decided,† I did not state it specifically, though that I must have noticed it is, I think, undeniable to any one who may go over this paper.

I am thus retrospective for once, and somewhat explanatory, as it happens that since the communications I have referred to were made, the Rev. Mr. Highton, in the course of one of his numerous and important electrical experiments, has observed that an evolution of sulphuretted hydrogen takes place under circumstances very similar to that I have already described. Thus this gentleman ascertained that graphite paired with zinc in an exciting fluid of sulphuric acid gave off sulphuretted hydrogen; and it is particularly the origin of the gas in this last case which I am anxious to discuss here, as there appears to be a very great diversity of opinion upon it; and what especially

* Trans. N.Z. Inst., III., p. 232.

† Trans. N.Z. Inst., III., Art. XXXIX., On the Capability of certain Sulphides to form the Negative Pole of a Galvanic Battery.

stimulates me to this action is, that so far as opinions upon it are antagonistic to the one I hold, my researches upon the subjects connected with it are either not taken into proper account, or else are completely ignored.

Thus the Rev. Mr. Highton, in communicating the fact instanced to the British Association, sitting at Brighton in 1872, referred the origin of the gas evolved to a decomposition of a portion of the sulphuric acid used, the constituents of this acid being, as he considered, hydrized to water and sulphuretted hydrogen by the nascent hydrogen liberated in the carbon pores during the process.

This statement, though eliciting much discussion at the meeting instanced, did not induce any one there to attempt the application of these published researches of mine thus indicated to the explanation of this phenomenon, but the majority of those who took part in this discussion sought rather to attribute this evolution to the decomposition of sulphide of iron in the graphite used, this substance being in fact a general constituent of graphite, and easily decomposed by sulphuric acid with liberation of the gas mentioned.

Both these assumptions appearing to me not only radically erroneous, but altogether superfluous, in face of the facts described in the published paper of mine instanced, I ventured in the "Chemical News"* to refer the Rev. Mr. Highton to these facts, and to suggest that the phenomena in question could be easily explained by taking these into proper consideration, and I received an answer† from that gentleman, which, except for certain suggestions, does little more than inform me that his opinions on this subject are unchanged.

This is the precise position of the question in dispute between us, and as it appears of some importance, from a chemical point of view, and may be also in connection with the very desirable object of freeing coke from sulphur, I now beg leave to treat the whole of it in a paper to you, such a course allowing me to discuss it at greater length and with more justice to myself than can well be attained within the limits which a correspondence column would necessarily impose upon me.

It will be seen, then, that there are three theories propounded for explaining the evolution of sulphuretted hydrogen from graphite or carbon under the circumstances named:—

(1.) The decomposition of sulphuric acid.

(2.) The decomposition of sulphide of iron present in the graphite or carbon itself.

(3.) The removal of absorbed sulphur from the graphite or carbon by aid of nascent hydrogen.

In relation to the first, I have ascertained that the gas in question is not evolved from carbon when paired with zinc in pure sulphuric acid, if only the

* Vol. XXVII., p. 116. † Vol. XXVII., p. 152.

carbon is free from sulphur; but if we allow the carbon a few seconds contact with sulphuretted hydrogen, wash it, connect as before, and even use pure hydrochloric acid as the exciting fluid, a great quantity of this gas is given off at the surface of such carbon.

These experiments are very simple ones, and appear to be decisive—at least they clearly show, when taken in connection with the prevalence of sulphuretted hydrogen in the air and the absorptive power of carbon for it, that the evolution of this gas described by Mr. Highton does not necessitate the decomposition of sulphuric acid. But, in answer to this, Mr. Highton asserts that "if any one will take a porous jar with a plate of carbon in the middle packed round with broken pieces of carbon, form it into a battery with amalgamated zinc, dilute sulphuric acid for an electrolyte, and set it to work through say twenty Ohms for twelve hours, I think he will find the evolution of sulphuretted hydrogen too great to be thus accounted for."

Now, I contend that if the suggestions conveyed in this paragraph were carried out, their only effect would be to encumber the case, and further, that the opinion Mr. Highton arrives at, being based upon hypothetical results merely, has not that force or certainty proper to any opinion the object of which is to controvert one affirmed to rest upon experimental evidence, as this does. If Mr. Highton is so sure of his ground that he thinks he can afford to exercise his courtesy by toning down in this manner what he conceives to be truth, I thank him for this manifestation towards me, but, while appreciating the kindly motive itself, I must express a wish that he had been more specific; and I may state here that my only reasons for delaying so long as I have in answering this letter have been the lack of this quality in it, and the hopes which I entertained that the question in dispute between us might ere this have been taken up by some one who would be unbiassed to either side by previous utterance or thought of his with regard to it.

However, to go back to the allegations I then made in reference to the paragraph itself, I would ask Mr. Highton what necessity, if any, is there to pile the carbon pole around with pieces of carbon? If juxtaposition of pieces of carbon with the carbon pole fundamentally affects the character of the results in regard to the question at issue, then I submit that Mr. Highton is leading me off from this question to the consideration of a phenomenon I have neither contemplated or disputed, which is, besides, new to chemistry, and so one that Mr. Highton, being the first to indicate, has the honourable right to be the first to investigate.

This modification by Mr. Highton would certainly have the tendency to largely increase the evolution of the gas in question and so to increase its duration, but still I contend this would not be to a greater extent than can be accounted for upon other grounds than those Mr. Highton has taken up. It

would, I think, be proper for Mr. Highton to determine the quantity of this gas which can be liberated from a certain weight of carbon by the means I have indicated before assigning a limit to it in the manner he has. In regard now to the "experimentum crucis" which Mr. Highton suggested to me for settling the question, viz., "to keep renewing the sulphuric acid" (of the battery of his just described) "till all sulphides accidentally present must be fully decomposed, and seeing whether evolution of sulphuretted hydrogen still went on." Upon the theory (not yet exploded) as to the infinite divisibility of matter, and owing to the length of time which would be necessary to detach by this means the bulk of the gas in question from the centre of the carbons used, I might with propriety decline to allow my theory upon this subject to stand or fall by the results of such an experiment. I have, however, tried the experiments more for relative than absolute results, and, as I expected, found a well-marked diminution in the yield of sulphuretted hydrogen as time proceeded.

This diminution is manifested very conspicuously to prepared lead paper when held over the battery. At first this is rapidly blackened, but after twenty-four hours have elapsed a light brown tint only is communicated after it has been in contact one hour with the gas evolved, and when the acid was renewed, the zinc cleaned, and the battery allowed to work another six hours, lead paper suspended in the same position as before did not manifest a change in colour for twelve hours; and so, making renewals of acid, but still retaining the same carbon pole, I at last got the evolution of sulphuretted hydrogen so far reduced that even when the battery was in good action it required two days' contact of the test paper with the gas issuing from the battery in order to get an indication of the presence of sulphuretted hydrogen. As above inferred, I do not expect that this gas could ever be wholly removed from a plate of carbon by this process, but I think my results show that it is given off in constantly diminishing quantity, no matter how often we renew the sulphuric acid, and this is all I contend for, as it shows clearly that this acid cannot be the source of the sulphur of the H^2S given off, as Mr. Highton asserts, since it is obvious that were it so the gas should be given off in quantities nearly uniform for equal times.

Regarding the supposition that nascent hydrogen in carbon pores should, according to the analogy of other chemical facts, form, with sulphuric acid, water and sulphuretted hydrogen, I am at a loss to know what facts are referred to by Mr. Highton, and therefore cannot debate this point. I admit, however, that porous carbon or platinum is capable of exercising decomposing and recomposing effects upon certain substances by what is termed provisionally catalytic action; but there is a line above which this action is not exercised, and it seems to me that the decomposition of sulphuric

acid in the way indicated is above it. Analogy cannot be always trusted as a guide, though as a useful suggestor of probabilities it is unrivalled.

As to the theory that the sulphide of iron in the carbon or graphite used is concerned in the production of this gas, Mr. Highton himself appears to have thoroughly settled this by proving that sulphuretted hydrogen is not generated when the poles of his battery are unconnected, sulphide of iron being, as is well known, decomposed with evolution of this gas on the mere contact of sulphuric acid with it, and this would of course go on with still more energy and rapidity when the iron compound is in juxtaposition with a negative substance, as carbon.

Having thus endeavoured to show the inability of either of these two theories to explain the phenomena described, I will now proceed to the next one, which is that I have always held and now hold upon this subject, viz., that the gas in question is derived, as to its sulphur at least, from the carbon itself.

I base this conclusion upon the following data :—

(1.) The metallic nature of graphitic carbon.

(2.) Its so termed absorptive power for sulphuretted hydrogen.

(3.) The probability that this power has been exercised by the graphite used by Mr. Highton.

(4.) The decomposition of metallic sulphides generally when connected voltaically with easily oxidizable metals.

(5.) That sulphuretted hydrogen is not evolved voltaically from charcoal free from sulphur, if the exciting acid, whether sulphuric or hydrochloric, is pure.

Of these data the only ones requiring consideration here, as not being already treated or detailed, is the metallic nature of carbon, and (in relation to the absorptive power of this substance for sulphuretted hydrogen) the form in which this gas or its sulphur is absorbed.

That carbon in the graphitic state is a metal has long since been promulgated, and without, as I believe, eliciting any controversy of a nature at all subversive to such an idea, indeed its relations when in this state, both to light and electricity, are so precisely those of metals generally to these forces, that, according to the manner by which we as yet distinguish metals from metalloids, we cannot avoid accepting this idea. Graphite, the substance here in view, is not, as we know, pure carbon, but it certainly bears the same relation to light and electricity as pure graphitic carbon does ; therefore we may, I think, correctly class it as a metal too (though an impure one) and possibly sustaining the same relations to pure graphitic carbon as hydrogenized palladium bears to pure palladium, both metals being impure although truly metallic.

Now, as to the form in which H^2S is absorbed by charcoal—that is, as we have seen, by impure metallic carbon—it is well known that those metals which

are somewhat difficult to oxidize can absorb H^2S, for instance, silver, mercury, gold, and platinum. It is further known that the removal is, in these cases, chemically brought about, the sulphur of the gas combining with the metal forming a true sulphide; why not, then, continue the analogy of graphitic carbon with these metals, by supposing that the absorption of this gas by such carbon is also a chemical action resulting in the formation of a sulphide of carbon analogous in some measure with the sulphides of the metals instanced? We can suppose that, according to the proclivities of these sulphides, they may be hydrous or anhydrous, but any way we must account for the hydrogen dissociated from the sulphur in this absorption, and this we cannot do better, I think, than by supposing it combined with oxygen to form water, free or combined, according as the sulphides are anhydrous or not.

I cannot see but that this is a legitimate conclusion; and though it would be very difficult to prove by analytical results that such is the case, it would, I believe, be quite as difficult to prove the reverse.

It may be averred, in response to this, that there is no physical change manifested in the carbon, and that the absorption is slight as computed upon the weight of solid material used; but we must consider that physical change, of a magnitude so great as to manifest itself to us, is not necessarily the consequence of even a profound chemical change in structure or composition. The sulphurizing of gold or platina for instance at common temperatures by the gaseous method does not exhibit itself optically, nor even gravimetrically to any ordinary weighing apparatus, yet the surface of these metals can, as we know, be covered with the compound thus formed, and so completely that they will not amalgamate while in this condition.

Again we must consider that the comparatively small extent to which this absorption can be carried on may be due to carbon being less quantivalent when in the graphitic or metallic state than it is now assumed to have, this being certainly computed for it as existing in the metalloidal state. Further, we know that hydrogen and other elements form a notable part of most graphitic carbons, especially of charcoal, and as these are, without doubt, in greater part combined with the carbon, we may have a compound to deal with in place of an element, and so a substance having yet a higher atomic equivalent. Besides, the greater part of this compound may, like that of gold and platinum with sulphur, be so situated as to be out of contact with the gas; also, the sulphuretted compound thus formed is possibly so firmly adherent to the carbon that it cannot scale off and so expose fresh surfaces (as rust of iron does), and it may be so insoluble in the menstruum in which the gas is administered that the thinnest films of this compound upon the carbon act as an effectual bar to further action of this kind, graphitic carbon in these particular relations of it to sulphur occupying in

reality a similar position to that which I have shown gold and platinum sustain to this substance.

Now, if all this appears correct—and the great probability is conceded that absorption of sulphuretted hydrogen by charcoal is a chemical one, resulting in the formation of sulphide of carbon—then I maintain that the evolution of this gas from the negative pole of the battery, as described by Mr. Highton, is, upon analogical grounds alone, precisely one of the effects we should anticipate on becoming acquainted with the general behaviour of metallic sulphides occupying the negative end of a galvanic battery; for, as before stated, I have proved such sulphides evolve sulphuretted hydrogen under these circumstances, and by a process which appears very simple, hydrogen (for which as to its chemical might Mr. Highton exhibits such great faith) being in this case, I believe, the agent, through the intense desire of which for consummating chemical alliances with approved substances, these compounds owe their origin in the instances cited.

However this may be brought about the gas is certainly generated when such sulphides are paired with more positive substances in sulphuric acid, and it proceeds from these sulphides. When, therefore, we refuse to allow that at least a portion of the sulphuretted hydrogen obtained by Mr. Highton from his carbon plate is derived and produced in this manner, we are breaking through very strong analogy indeed; and, what is even unphilosophical, we are spurning analogies of this character to embrace (in the case of the alleged decomposition of sulphuric acid by nascent hydrogen) a hypothesis which I submit, with all deference to Mr. Highton, is not yet supported either upon analogical or experimental evidence.

In conclusion, what I conceive as legitimate deductions from long known facts, obvious analogies, and the results of experimental evidence, collectively support the view that the H^2S observed, first by myself and next by Mr. Highton, to escape from a battery in action, of which graphite is the negative pole—is not a product of the decomposition of either sulphuric acid or any ferruginous sulphide, as has been maintained, but is liberated as to its sulphur from combination with the carbon of these batteries—this substance being, from its well-known proclivities, certain to be in a sulphurized state when used by Mr. Highton.

I have only to add that, even were sulphur only present in graphitic carbon as a component part of sulphurous acid, the effects as observed by Mr. Highton would be precisely the same as those he has stated; so that before it would be correct to assert the decomposition of sulphuric acid by nascent hydrogen in contact with carbon, we should not only be certain that sulphides are absent but sulphites or sulphurous acid also.

Art. LXIV.—*On Duplex Telegraphy.* By Charles Lemon, General Manager, New Zealand Telegraphs.

Plates XXVI. and XXVII.

[*Read before the Wellington Philosophical Society, 21st November,* 1874.]

My attention was drawn to the system of duplex telegraphy by an extract from a paper read by Mr. Culley before the Society of Telegraph Engineers in London, and which was published in the "Telegraph Journal."

The system at present in use in England is based on the differential principle. The system that has been adopted in New Zealand is based on the Wheatstone Bridge principle. The differential principle is arrived at by producing an equality of currents. The Wheatstone Bridge principle is based upon an equality of tensions (now called potential). Tension or potential may be considered as a term analogous to pressure, as applied to water.

Before proceeding to describe the details on which duplex telegraphy is worked in New Zealand, it will be as well perhaps to give the following illustration as to the distribution of tensions in a split or derived circuit:—Figure 1 (Plate XXVI.) represents two pipes running parallel to one another. If at the point *x* a stream of water is made to enter both pipes, the pressure in each will be precisely the same. Now turning to figure 2. Supposing a connecting pipe, *z w*, be made between the two on the same level, at a point in the centre of the connecting pipe, there will be no motion, for the pressure on each end of the branch will be precisely the same; for where two forces meet one another, both travelling with equal and sustained velocities, at that point of juncture there is no motion, the two forces having equal and opposite effects, and thus neutralizing the action of each other. The case is different, however, if we make the connection at a lower level in the one pipe than in the other, as in figure 3. Although the pressure in each pipe still remains the same, the flow from *g* to the point *m* is to a lower level, therefore the pressure in the connecting pipe is all the one way, or nearly so.

Now, the principle on which duplex telegraphy is applied in New Zealand is on precisely the same conditions as shown in figure 2; for if we consider A B and C D to be two electric circuits branching from one conductor at *x* and joining again at *y*, the proportionate tension or potential is the same at every equal proportional part of the resistance of the two circuits; and at any point in either circuit, provided those conditions be observed, connection between the two circuits may be made, and there will be no tendency for the current circulating in either circuit to pass across from one circuit to the other, for although there will be a tendency for the current circulating in A B to pass to C D by way of *z w*, still as there is the same tendency for the current circulating in C D to pass to A B by way of *w z*, the two opposites neutralize one another;

hence there is no current moving in *z w*, for the potential is equal at the points *z* and *w* in either circuit; a galvanometer or relay placed in this cross connection would show no sign of a current passing, for in both cases the currents will have equal and opposite effects on the instruments so placed in the cross connection. This condition will hold good even though the resistance of one circuit be double that of the other, for at definite proportional points equal potentials exist, and no currents can therefore pass from one point to the other in the branch connection.

In making the foregoing statement, I wish it to be understood that, although no current passes from *z* to *w* or from *w* to *z* when the currents are circulating in the two circuits A B and C D, still I am of the opinion that the coils of the instrument placed in the cross connection *z w* are charged from either end at the same instant of time, and remain so charged so long as the current is circulating in both the circuits of A B and C D; and at the moment the current ceases to circulate in both circuits (which will be at one and the same time), the charges that have rushed in from either side make their exit the way they entered, and through their having the same potential and the same velocity, any effect the outgoing current on the one side might have on the instrument so placed in the cross connection is counteracted by the outgoing current on the other side. This can be easily proved by placing a galvanometer exactly in the middle of a circuit, and sending the same current, equal as regards quantity and potential, from either end. When the one current is sent, the needle lies over to the one side, when the other current is sent the needle lies over to the other side; but when both currents are sent on the line at one and the same time the needle keeps its normal or upright position, for the simple reason that both currents are alike in their potential, and consequently have equal and opposite effects on the needle, or, in other words, the two forces being equal, they apparently neutralize the effects of each other. But let the potential of one current (the quantity on both sides being still the same) be more than the other, then the effect of the strongest current will be just weakened by an amount equal to the potential of the opposite and weaker current, for the pressure on the one side will be greater than the other. It is by being able to balance these potentials at two definite proportional points opposite to each other, that duplex telegraphy on the Wheatstone Bridge principle is made practicable.

The term "current," I would here remark, is only used for convenience sake. What electricity is, is not known as yet. Some writers seem to infer that it is another form of heat. All writers agree, however, in treating it as a force; and in its utilization, by applying the laws that govern forces, results looked for can always be obtained, provided due care is taken as regards its peculiar nature whilst conducting experiments by its agency.

I have endeavoured, in the foregoing, to render intelligible how two currents circulating in two conductors parallel to each other can continue to do so without interfering with each other when connected, provided certain conditions are observed. The attached diagram (Pl. XXVI., fig. 4) shows the exact proportions in a duplex circuit on the principle of the Wheatstone Bridge, and is also a fac-simile of the plan, both as regards the relative values of the different resistances and the position of the apparatus, upon which duplex telegraphy is conducted in one of the wires in the Cook Strait cable, now in successful operation since the 18th June last.

It will be seen on reference to the diagram that the same proportions, as regards units of resistance, are employed at either end of the duplex circuit, the letters A and B representing the two ends of the cable and the apparatus employed at each end. If the arrangement at one station (A, for instance) is explained, the same may be considered as representing the conditions that exist at B.

The battery at A consists of ten cells (modified Daniell's Gravity Battery) of an internal resistance equal to 100 units or thereabouts. The copper pole is connected to the key, and the zinc pole is placed direct to earth. When the key is depressed the copper current flows, one portion passing to line and cable through the resistance of 800 units, and the other to the artificial resistance (520) through the resistance (400). The proportions in the bridge are 800 on the one side and 400 on the other, so that when the current arrives at H it divides in proportional parts, two-thirds of the current passing by way of H D through the artificial resistance to earth, and the remaining one-third by way of H C to the line, and after traversing the line and cable arrives at E, and then splits again, two-thirds passing by way of E F to earth, and the remaining one-third by way of E B to earth. The two-thirds that passes through E F works the relay, and thus records the signal that is sent from station A. Turning again to station A, it will be seen that the out-going currents, as I said before, divide proportionally at H, two-thirds passing by way of H D, and one-third by way of H C; and as these proportions are still maintained beyond the points C and D on either side of the relay, there is no temptation for the current which traverses H C to pass through C D, nor is there any temptation for the current which traverses H D to pass through D C; for as the currents in each of the above circuits are proportional throughout, and the potential of each current the same at C and D, consequently they exercise equal and opposite effects on the relay in C and D, and therefore when the currents are circulating in H C and H D, their potentials being the same, there is no current in C D; thus the first step towards effecting duplex has been accomplished—viz., we are enabled to send the home current to line without affecting the home-receiving apparatus. But supposing, instead of the artificial resistance (520 units), we

Fig. 1.

Fig. 2.

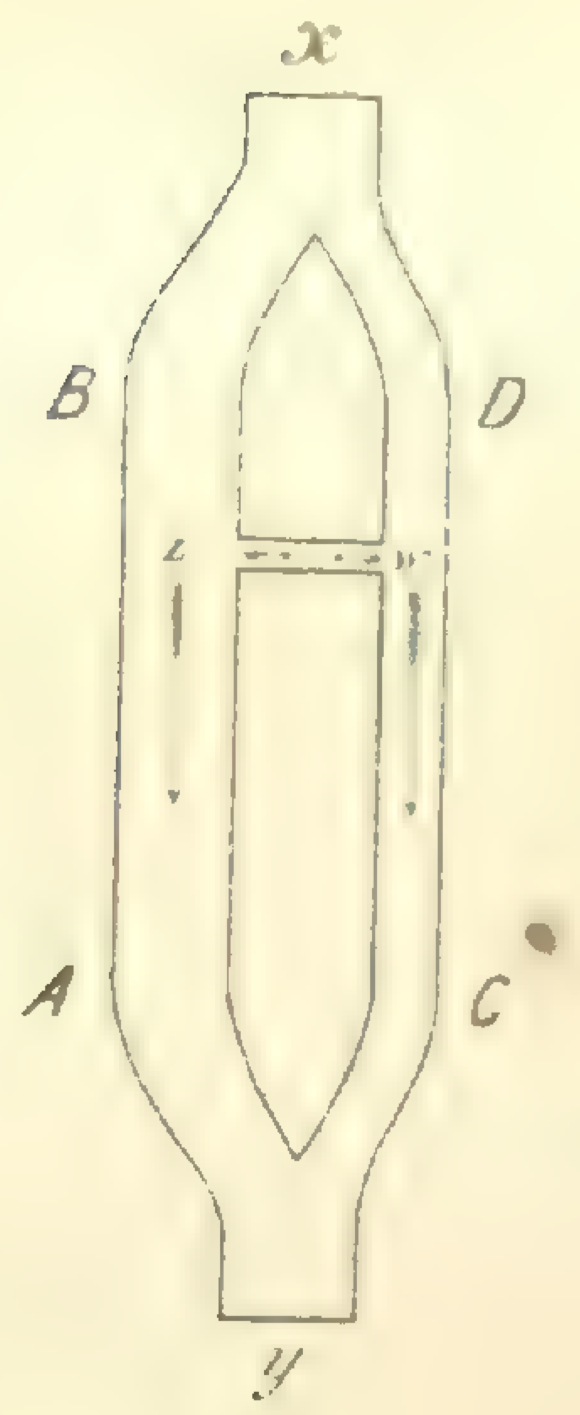


Fig. 3.

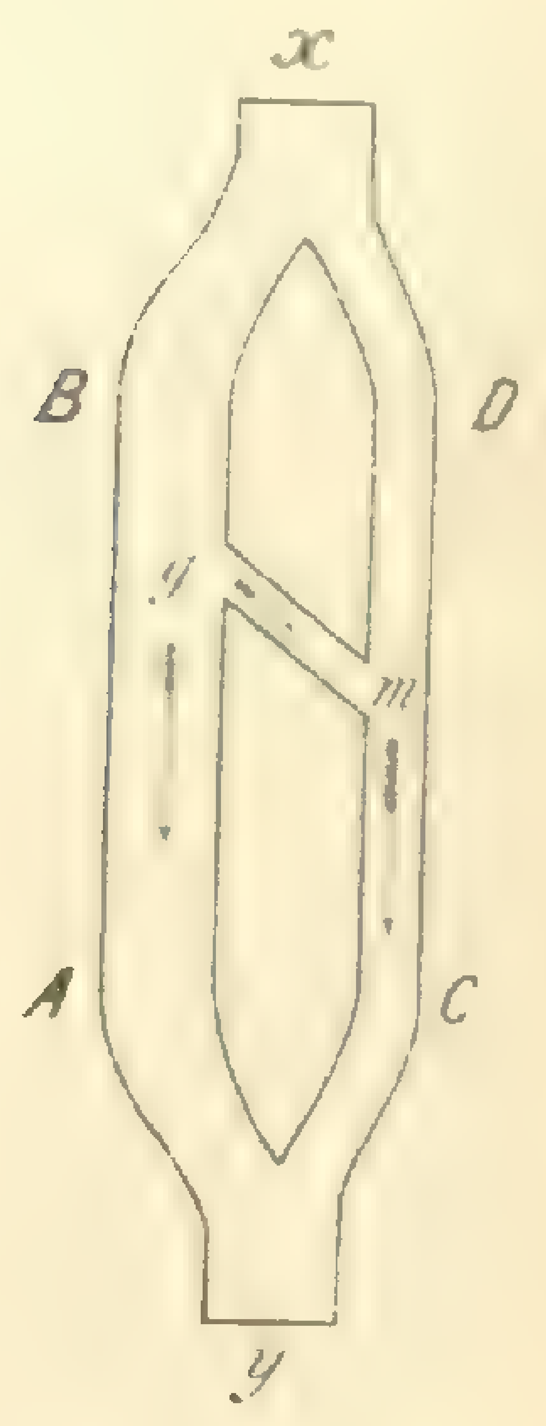
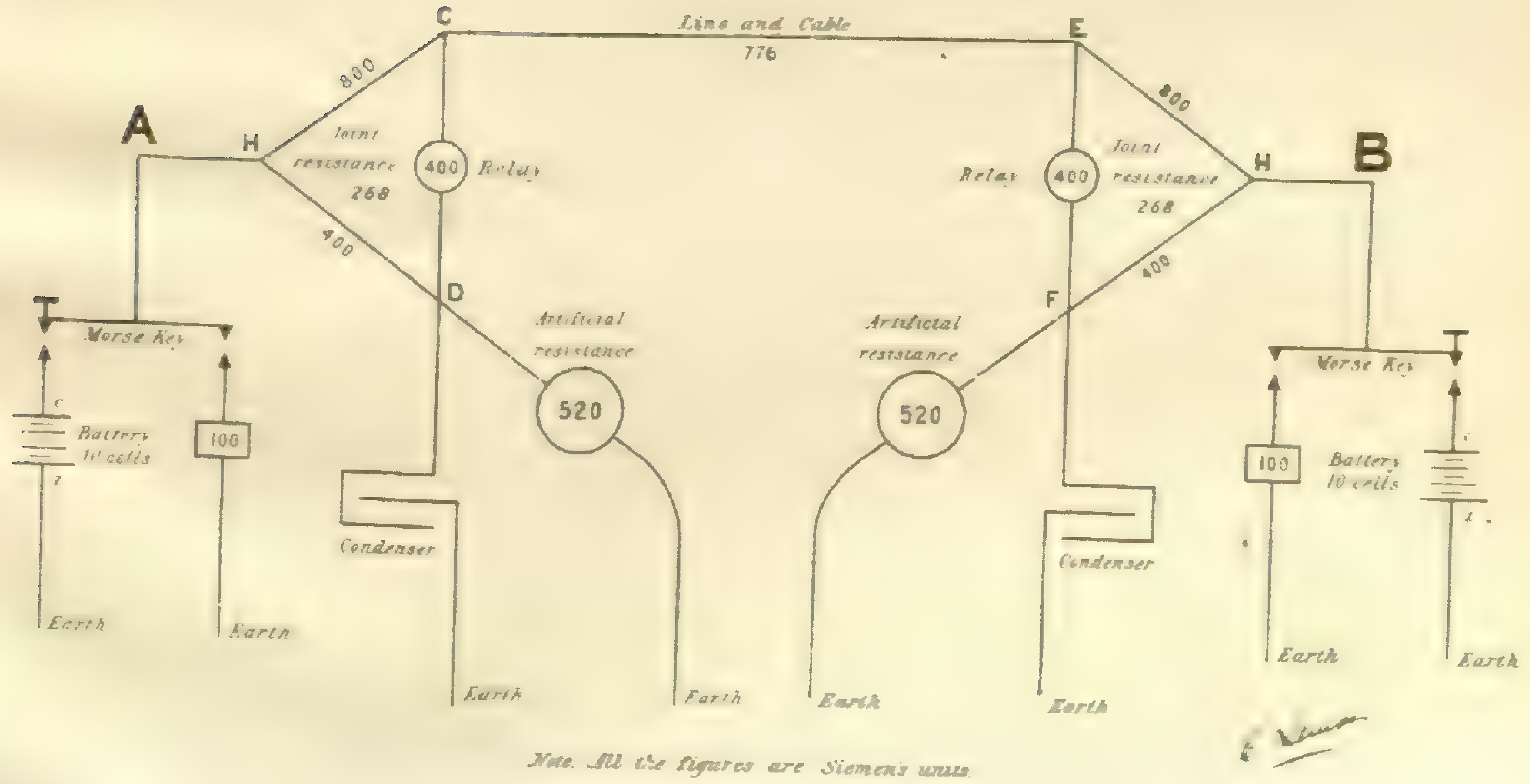


Fig. 4.



Note. All the figures are Siemen's units.

To accompany Paper by C. Lemon.

place only 200 there, what would be the result? Through our lowering the potential at D, the current arriving at C, instead of passing to line, a portion of it would rush through C D. The effect of this would be similar to the effect I described in figure 3, when two water-pipes have a connection made between them from a higher to a lower level; so, in like manner, a greater portion of the current arriving at C would find its shortest road to earth to be through C D, as the potential at the points C and D would have been disturbed by altering the artificial resistance; thus the first step towards accomplishing duplex would be defeated.

It will be seen, on turning to the diagram, that between the back contact of the key and the earth, 100 units resistance is inserted. This is placed there to prevent the balance being disturbed when the key is at rest; for as the battery in itself represents an internal resistance of 100 units, by inserting the 100 units resistance on the back connection of the key, it follows that, whether the key is up or down, the same resistance is always in circuit. I may remark, however, that there is an instant of time when the key is on the hang—that is to say, when neither back nor front contact is made—when both these resistances are cut out, but, as far as my experience has led me, I have found no inconvenience from it. I have, however, in order to reduce the interval between the two contacts, devised a key which practically removes the difficulty, as near as it is possible to do so. This resistance in the back connection of the key will vary as the resistance of the battery varies; for instance, on a duplex circuit of 200 miles, by experiment, I find it requires thirty cells to work it efficiently; and as thirty cells are equal in their internal resistance to about 300 units, it takes 300 units in the back connection of the key to preserve the required conditions.

It will be observed that the line measures 776 units resistance, and that the artificial resistance measures 520, which is equal to one-half the resistance of the line, and one-half the joint resistance (268 units) at the B side. The same applies to the A side when telegraphing from B. This joint resistance, 268 units, is the actual resistance that the current measures when arriving at E or C, as the case may be, and is arrived at in the first instance by testing with a galvanometer at E or C, the circuit being through E H, E F direct to earth, and from H F direct to earth, and from H to earth through the 100 units in back contact of key. It may appear strange that whilst the resistances that the current arriving at E has in its path to travel should in their sum represent $800 + 400 + 400 + 100 = 1{,}700$ units, that the actual resistance in circuit is only 268 units; but it must be borne in mind that instead of one path for the current there are no less than four for it to distribute itself over, consequently the resistance in the aggregate is lessened thereby.

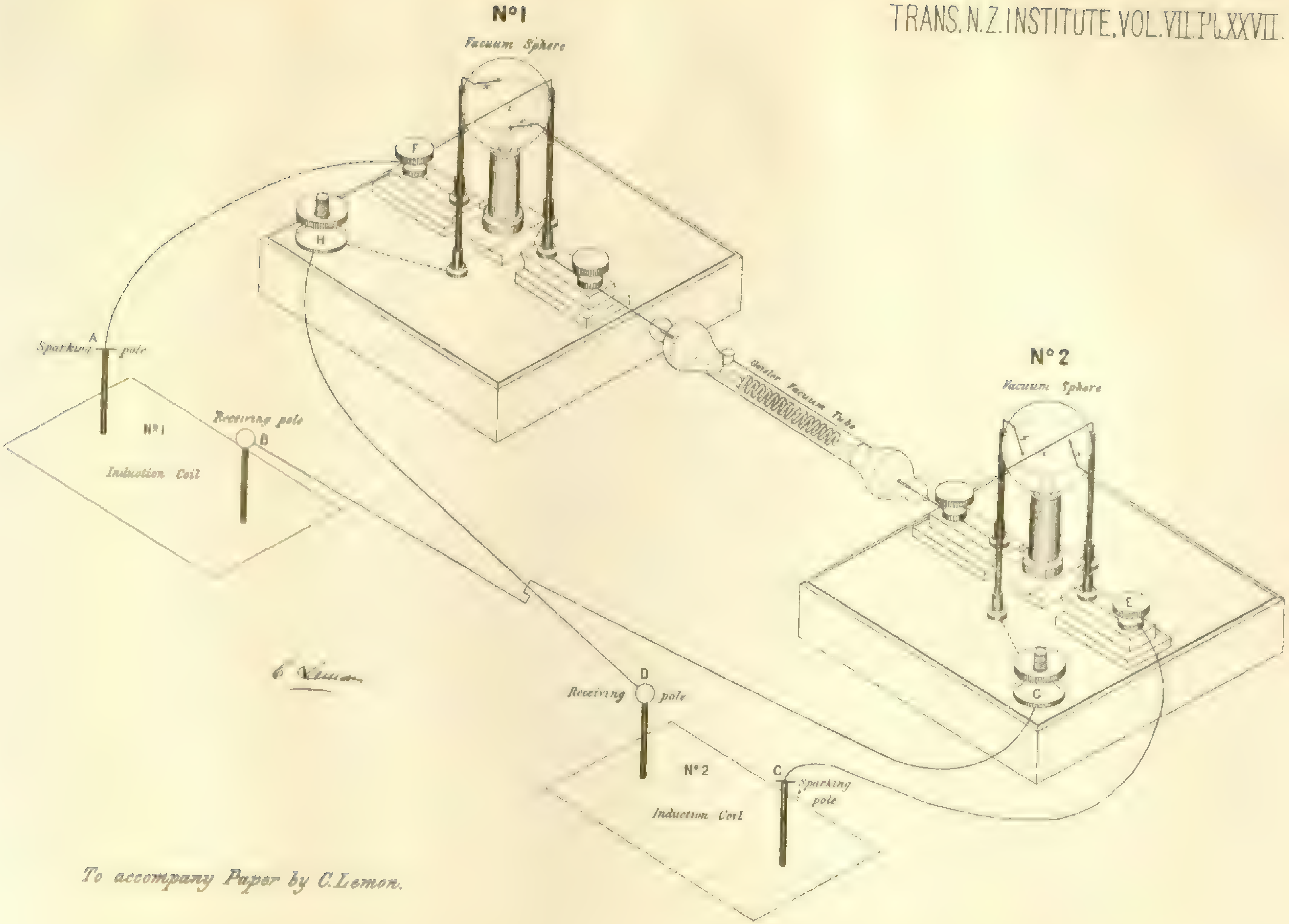
The condensers, which are placed at F and D respectively, are used to balance the static induction of the line. On long lines they are most valuable adjuncts, but on short lines do not appear to be necessary. Duplex telegraphy has to thank Mr. Stearns, of America, for this addition. Doubtless, so far as we know at present, and with the present appliances, it would not be possible to work duplex circuits of any length without the aid of the condenser. The condenser is made of a proportional capacity equal to the capacity of the real line. The exact action of the condenser within itself is not known, but I am of the opinion that it acts as a sort of storehouse for the current, receiving a portion of the charge when the current is sent on to the line, and, when the current ceases to flow, gradually discharges itself, and by so doing neutralizes the static discharge of the real line, that is the second flow of the current that is induced in the line in the opposite direction, or the residue of the charge which still clings to the conductor after the first rush of the current has passed.

I have now described all the conditions under which duplex is worked by the Wheatstone Bridge principle. I have shown how A can telegraph to B without disturbing his own apparatus, and how B can do the same.

The next step is to describe the effect when both A and B send their currents simultaneously to line, and how it is that the one current does not interfere with the other when both are on the line at once. The question is, do they pass one another? If not, how does A's signal record itself at B, and *vice versâ*, without the one interfering with the other, or mixing up, or clashing with each other.

It has been stated "that the two currents do not pass one another as has been imagined, but that, when both stations signal at the same time, the current sent by either station acts upon the distant instrument by determining whether the line or the rheostat (the artificial resistance) shall offer the easier path for the currents originating there."

The results of an experiment I made by the aid of two induction coils (each coil giving a spark of $1\frac{1}{2}$ inch in air), have led me, however, to a somewhat different conclusion, and I am inclined to think that the currents sent from either end do actually pass one another, or at any rate exchange impulses, and so record the opposite signal. If the currents, instead of passing one another, simply exchange impulses, they only obey one of the laws of motion; for if we treat the two currents as two elastic bodies moving with equal velocities, and in opposite directions, at the point of contact they are each acted upon in their turn, and in the opposite direction, for as the motion of two bodies when started from a state of rest is in the direction given them by their first impulse, any change in direction after collision from that first taken must therefore be due to an exchange of force or impulse at the time of such collision.



To accompany Paper by C. Lemon.

My experiment with the two induction coils was as shown in Plate XXVII. The two vacuum spheres, $1\frac{1}{2}$ inch in diameter, had platinum wire points (x) at a distance of about half an inch above and below a platinum wire (z), that went right through from one side of each sphere to the other at right angles, and also axial, as shown in diagram. The sparking poles A and C of the two induction coils were joined to F and E of the spheres, and the receiving poles B and D of the coils joined to H and G; thus the spark from No. 1 coil would pass from A to F, then through the No. 1 sphere, then across the vacuum tube, then on to G by way of z, and back to its own receiving pole B. The spark from coil No. 2 would pass from C to E, then spark through the No. 2 sphere, then through the vacuum tube, then on to H by way of z, and back to its own receiving pole D; thus, by these means, the phenomena of two currents of electricity passing through the same space and in opposite directions were rendered visible.

The vacuum tube, in addition to the spiral tube passing through it, was in globular form at each end, when the spark passed out of the sphere from coil No. 1 (its spark being passed though by itself first, and then No. 2 treated in the same manner): in the end of the vacuum tube, next the coil No. 1, the light in it assumed a striped appearance, and, after passing through the tube, assumed in the other end a glowing-like appearance, like teased-out cotton wool. The spark from No. 2 coil, treated in the same manner, showed just the same results in the contrary direction. When only one coil was in operation, the light in the spiral tube was very luminous; but when both were in operation at one and the same time, this light was rendered doubly so, thus proving there was double the quantity of light in the tube when both currents were on at the same time. This was most distinctly visible.

Another experiment I tried was connecting a Morse key between the one pole of the battery and the make and break of each coil:—When the key was depressed the flashes of flame could be distinctly seen discharging at either end of the vacuum, the signal coming from No. 2 could be plainly seen and read off at the H end of the tube in the cotton wool form described, whilst the striped appearance of the spark in the H end (the same end) of the tube from coil No. 1 could also be seen there. Previous to the last experiment above referred to, I made another by detaching the two receiving poles from G and H, and joining them together, so that the spark that passed from No. 1 coil before it could get back to its own receiving pole was forced to travel through the secondary wire of coil No. 2. Coil No. 2 had to perform the same operation as No. 1 before its spark could reach its own receiving pole. When the connections were joined up this way, at intervals, a spark would pass in either coil direct from its own sparking pole to its own receiving pole, and this whilst the light was in the vacuum tube. It would appear, from

this sparking across, as if every now and again the resistance to the passage of the current from either side was in a measure increased, and rather than the whole of it would pass though the vacuum tube a portion preferred passing direct.

My first experiment in this direction resulted in some slight damage to one of the coils (the condenser being destroyed), and on my second experiment of the same nature, through the accident resulting from the first, I was not inclined to prolong the experiment beyond being able to satisfy myself that the current still continued to pass in the manner described in the first experiment, when the receiving poles were joined to their respective spheres at G and H.

It will thus be seen from the foregoing description of the experiments above named, that there is some tangible ground for believing that the currents in duplex telegraphy do pass one another. The subject yet, in my opinion, requires further investigation before that point can be finally settled; possibly it may never be conclusively proved either one way or the other, or, at any rate, not until such time as we are enabled to state what electricity itself is. Looking at it from a common-sense point of view, however, one would naturally come to the conclusion that they must pass, or that the currents, like two bodies meeting each other, exchange impulses, and thus cause the opposite signal, or rather the will of each sender, to be transmitted to its destination.

The foregoing method in working duplex is on the open-circuit principle; that is to say, the signal is made by sending the current to line (charging the wire with electricity from the battery for the time being).

It is possible, and perfectly practicable, however, to work duplex, in accordance with the arrangement described, by the constant current, or closed circuit, by making the following slight alterations in the manner of joining up. The plan is as follows:—The battery is placed at the back connection of the key, with the zinc current to line, and the resistance to balance the battery is placed in the front contact, the earth connections being still maintained in both cases, as shown. The relays are placed so as to receive the opposite current to that sent from the battery, and are so adjusted that when the current is on the line (which will be when the key is at rest) the tongue of the relay is held on the insulated stop by the current entering the relay, weakening the magnetism on the side it enters, and strengthening the magnetism on the side the insulated stop is on. As soon as the key is moved, and contact made on the front anvil, through the current immediately leaving the line, the opposite pole of the relay reasserts its sway and attracts the tongue of the relay, and in doing so closes the local circuit, and thus records the signal.

The relays used in either of the foregoing systems are Siemens' polarized relays, and all the values given are in Siemens' units.

In the plan showing the system on which duplex is worked on the No. 3 wire in the Cook Strait cable, for convenience sake the local circuits are omitted.

Art. LXV.—*On a Modification of the Electric Lamp for projecting the Spectra of different Metals on the Screen.* By A. W. Bickerton, F.C.S., Professor of Chemistry in Canterbury College.

[*Read before the Philosophical Institute of Canterbury, 1st October,* 1874.]

It is a matter of some difficulty, when using an ordinary electric lamp, to project the spectra of several metals on the screen in quick succession. A special piece of apparatus for this purpose is described by Mr. Lockyer in his book, in which a circle of ordinary gas carbon cups are used. I have made the following modification of the ordinary lamp, and have found the result very successful.

The lower carbon is taken out, and into the holder is placed a stout cylinder of brass with a pin turned on the top; on this pin is a plate of gas carbon three inches in diameter and half-an-inch thick, with a hole in the centre through which passes the brass pin. The carbon disc is thus free to revolve round the top of the pin; near the edge is a circle of small hollows into which the pieces of the metals are placed. The upper carbon would now come in contact with the top of the brass pin; in order to bring the upper carbon above the hollows containing the metals, the top arm is provided with a slot to slide out. With this arrangement the spectra of a number of metals may be projected on the screen in a few minutes with the greatest ease, the metals burning with an amount of steadiness I have not seen before. A piece of copper about the size of half a pea was placed in one of the hollows and completely burnt away without any attention.

The lamp I have is one of Browning's, and it acts most satisfactorily, but the positive carbon is placed at the top. I find that in order to burn the metals with a steady light the positive must be at the bottom; when it is at the top it invariably begins to vibrate after a little time, and sometimes throws the metal out of the cup. I have not yet noticed if this is the case when using the ordinary carbon cups. The steadiness of the arc is probably due to the fact that the large mass of the carbon plate prevents it from becoming much heated, so that the convection currents, which I believe to be the cause of the arc (see my paper, Phil. Mag., Dec., 1873), have naturally a greater tendency to spring from the heated metal than the cold carbon. So small is the heat developed in the carbon that it remains quite black, and may be safely turned round with the hand.

ART. LXVI.—*Notes on the Colouring Matter of* Hæmatococcus sanguineus.
By LLEWELLYN POWELL, M.D.

[*Read before the Philosophical Institute of Canterbury, 2nd July,* 1874.]

AT the April meeting of the Society, a short paper, by Dr. Berggren, of the University of Lund, on the colouration of wool by *Hæmatococcus sanguineus,* was read.* A specimen was shown beneath the microscope exhibiting the dried and deformed cells of the alga nearly colourless, the fibres of wool being tinted of a pinkish hue. I have thought that some observations of my own on the colouring matter of *Hæmatococcus* may be worth recording in connection with Dr. Berggren's paper.

The alga consists of a diffuse formless frond found in damp places, beneath the drip of the eaves of houses, and such like. It has a dull brownish red or maroon tint, and very closely resembles a patch of half-dried blood ; this resemblance is embodied in the various names—*Hæmatococcus sanguineus, Palmella cruenta,* and the popular name, gory dew ; when quite dry the colour changes to a pinky lilac or peach colour. The frond consists of numberless discrete spherical cells embedded in a structureless matrix ; the cells have beneath the microscope a pale orange red tint, the matrix being colourless.

Water, whether cold or at a boiling temperature, appears to have no action upon the colouring matter. Solution of ammonia, or other alkali, immediately changes the colour of the cells to a bright olive green.

If the frond be boiled in alcohol the spirit acquires a deep green tint, exhibiting the characteristic absorption spectrum of chlorophyll—a sharply defined black band in the extreme red.

Glycerine extracts at ordinary temperatures a colouring matter having definite characteristics. The solution of this principle in glycerine is dichroic, having by transmitted light a very beautiful carmine tint, in fact the hue is scarcely distinguishable from a very dilute ammoniacal solution of carmine. By reflected light, however, there is a very remarkable difference, for, whereas the carmine solution appears unchanged, the solution of the colouring principle of the *Hæmatococcus* exhibits a luminous orange cloudiness ; by artificial light this is dingy yellow.

The colouring matter gives a definite absorption spectrum, consisting of a broad band commencing with a well-defined dark edge a short distance nearer the blue than the sodium line D, or about the centre of the fourth black band of Beale's absorption scale, and shades off gradually to E, where it loses itself. The spectrum may be advantageously compared with that of the solution of carmine, which, with an almost exactly similar tint, gives however a totally different spectrum, consisting of three not very well-defined bands.

* See Art. LV.

If solution of ammonia be added to the solution of the colouring matter in glycerine, it completely bleaches it without communicating any green tint. I propose to call this colouring principle Palmellin.

The Palmellin appears to be present in the *Hæmatococcus* in combination with chlorophyll. I am unable to arrive at any conclusion as to what acted as the solvent of the Palmellin in the case of the tinted wool.

Dr. Haast has given me a specimen of wool deeply tinted of a dingy olive green off a sheep on Mr. Studholme's station, Waimate. The idea occurred to us that possibly this also might be coloured by some cryptogam. I find that the green colouring matter is soluble in spirit; it is certainly not chlorophyll, giving no definite absorption spectrum. It is probably some mineral dye, but I am unable to say what.

Accompanying these notes is a diagram of the spectrum of Palmellin, compared with that of fresh blood, which is always at hand for comparison.

Art. LXVII.—*Notes on the Chemical Properties of some of the Strata from Mr. Firth's Well at Mount Eden.* By J. A. Pond.

[*Read before the Auckland Institute, 21st September,* 1874.]

In bringing this subject before the Society, it was not so much with a view of adding largely to the evidence relative to the constituents of the strata in question, as to keep alive the interest exhibited by the fact of the discovery of vegetable markings two hundred feet below the base of Mount Eden. In considering the different strata gone through, I have confined my attention chiefly to those marked *d* and *c* on Mr. Firth's plan,* as the *c* stratum contains the earliest vestiges of organic impressions, and the difference in colour between the adjoining earth led me to choose these two more prominently.

The samples in question differ slightly in their chemical composition, the following being the analysis of *d* and *c* samples :—

d.		c.	
Silica...	66·3	Silica...	75·5
Sesquioxide of iron	12·1	Sesquioxide of iron	17·4
Alumina	19·3	Alumina	7·1
Lime...	·7	Lime...	1·1
Chloride of sodium...	a trace	Chloride of sodium...	a trace
Water	4·	Water	2·
	102·4		103·1

The excess is owing to protoxide of iron in small quantity in both samples reduced to peroxide.

* See table at end of Art. LXXV.

The samples are meagre in a chemical point of view, the chief difference being in the disproportion in alumina and lime in the two samples.

When viewed microscopically a marked distinction will be found between the lowest deposit and the upper ones, as the particles of the one in question are angular, sharp edged, and in a large measure pure fragments of silica interspersed with argillaceous earth with peroxide of iron; the others, on the contrary, are composed of abraded grains of siliceous sand permeated with hydrated peroxide of iron, and most probably placed in their present position by the action of water.

This seems peculiarly confirmatory of Mr. Firth's conclusion relative to this portion of the strata having been at one time the bottom of a lake; the *d* stratum of which having been formed by an upward flow of molten lava coming in contact with sand containing bisulphide of iron, found all through this part of New Zealand, would have the effect as noted, while the other strata would take some time to form, by the action of water, to their present thickness. The *b* sample is undoubtedly laid under water, and contains patches of obsidian and other volcanic matter distributed arbitrarily throughout. This and the *a* deposit contain the greatest traces of organic markings, though the latter is less crushed and displaced than the former, leading to the inference that the upper stratum had become hard and firm, probably in the hot summer months before another eruption entirely covered it with volcanic ash.

In the cylindrical holes in samples *a* and *b*, which have undoubtedly contained stems and roots of plants, I found a white deposit where uncontaminated by adhesion to the sides of the holes, when it had a brownish hue. On examination I found the white portion to be pure silica tinged at the junction with the side with peroxide of iron. In no instance could I detect any vegetable formation with the microscope in the deposit, but simply rough granular cohering particles; nor were there in any of the strata, so far as I could note, any evidences of organic matter other than that already referred to.

In reference to the amount of siliceous matter in the tubes, I would add that I know of no plant with the same diameter of stem that could deposit so large an amount of silica, certainly not the raupo, but this is not necessary to be proven in this instance. Nor would the excess of this base disprove the vegetable origin of the holes, as silica is volatile in the superheated vapour of water, and is deposited during condensation of the steam. This would probably account for the excess of the deposit, as the volcanic matter falling so close to the place of its ejection would fall upon the sandy soil, which, no matter how dry the land might be, would, in the presence of vegetation, obtain sufficient water to volatilise and deposit silica in the orifices that had originally contained the stems of the plants. One other point worth

mentioning is the increase of lime in the upper beds, pointing to a gradual infiltration from some of the volcanic beds of later deposition.

I cannot help thinking that this subject sadly needs the attention of some of our geologists more particularly, and that in so doing a rich field would be brought before them. Dr. Hochstetter, speaking on extinct volcanoes, and particularly of this locality, instances the rising of Monte Nuovo, near Naples, which in two days and nights grew to the height of 400 feet, and remarks, "we may venture to say that cones, such as Mount Eden, are likely to have sprung up in the course of a few days."

Now, from Mr. Firth's researches we have seen that this volcano, when in action, must have been intermittent to have allowed time for the deposition of the vegetable-bearing strata *b* and *a*, with the volcanic ash between them, and for the clothing the same on each occasion with vegetation before its instant destruction by the hot débris. But with respect to the several eruptions later than this period, and mentioned in Mr. Firth's paper to the number of five, I think it is very probable that they will, on examination, resolve into a smaller number of perhaps very short duration, as in the presence of so many craters, and in this instance so close to the base of the largest, enormous masses would be ejected, taking the form of scoria, ash, or mud, as the absence or presence of water with the consequent steam and terrific pressure would determine. To decide this question, however, great care would have to be exercised in the examination of the surfaces of the different strata, as in many instances minerals when first ejected in volcanic matter are in the state of sulphides or sulphurets, which, by exposure to the action of air and water for any length of time would become oxidized, and, in the presence of iron, immediately discernible. By this means a very close approximate to time could be made in many instances, giving reliable data as the basis for future calculations on this very interesting subject.

V.—GEOLOGY.

Art. LXVIII.—*Notes on Dr. Haast's supposed Pleistocene Glaciation of New Zealand.* By W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 15th August*, 1874.]

In the course of the last year's proceedings of this Society I had the honour of submitting to it some observations upon the remains of extensive but now extinct glaciers, which occur in the principal valleys of the great mountain range of the South Island, in which I attributed the origin and subsequent disappearance of the glaciers which have left these evidences of their former existence, to oscillations in the level of the land. As I then pointed out, the views embodied in my paper differ materially from those propounded by Dr. Haast, on the same subject, in a report to the Provincial Government of Canterbury in 1864; but as he has lately reasserted the views contained in that report in their entirety, I propose now to examine them at some length, in order to show, more fully than I attempted to do in my last paper, the grounds upon which I differ with him; and I do this the less unwillingly, because, in the first place, Dr. Haast has challenged criticism, and because, in the next place, the right determination of the question at issue between us is of considerable importance in connection with our enquiries into the existing physical features of these islands.

My own views, as stated in my paper of last year, are,—That at the close of the miocene period the South Island generally began to rise, and that its central mountain chain ultimately attained an elevation exceeding its present altitude above sea level by some 4000 or 5000 feet. That during the period of maximum elevation all the main valleys in this central range were occupied by glaciers, each of which was, roughly speaking, proportionate in size to the altitude of the mountains and to the extent of the drainage system in which its own particular valley originated, and extended down its valley to a distance proportionate to its own mass. That this period of elevation was followed by a depression to an extent which, probably, exceeded the maximum elevation above mentioned. That, as a result of this depression, the glaciers occupying valleys in those parts of the range which had not attained, during the period of maximum elevation, a greater altitude than 13,000 to 14,000 feet above sea level disappeared. And that although, in postpliocene times, there had been a re-elevation of the land, during which the glaciers now existing in the valleys radiating from Mount Cook again advanced, occupying, with slight variation,

their present positions ever since, yet that this re-elevation was not sufficiently great to cause the formation anew of glaciers in any parts of the range in which they do not now exist.

The views propounded by Dr. Haast are, as I am about to show, entirely different, except in so far as he has associated the glaciation mentioned in his report with an elevation of the land. As will be seen in the sequel, our first great point of difference is as to the time when the glaciation to which the glacier remains in question are referable took place ; for, whilst I contend that it occurred during an elevation of the land commencing at the close of the miocene, and in all probability continued during a large portion of the pliocene period, he states that these islands were entirely submerged during and until the close of the tertiary epoch, and that the glaciation mentioned in his report (and of which *he*, also, considers the existing glaciers in the Mount Cook valleys to be continuing remnants) began almost coincidently with the re-emergence of the land, increasing in intensity with increasing elevation.

Our next great point of difference is as to the extent of the glaciation itself, for, whilst I contend that it never exceeded that which would occur, in the latitude of New Zealand, in a range of mountains averaging 14,000 feet in height and exposed to physical conditions similar to those which now exist, except, of course, in parts of the range which in the general rise of the land would attain an elevation materially exceeding that altitude, Dr. Haast contends that it was an universal glaciation, similar to that which now exists in Greenland and in the antarctic lands. He tells us, indeed, in the report in question (and throughout this paper I intend to quote his own words, merely changing the present to the past tense where such a course will best fit in with my own language), "that it was not necessary for him to give a picture of the desolate aspect of the country in those pleistocene times, but that, when recalling the descriptions of Greenland by Dr. Kane, and of other arctic and antarctic explorers, it brought vividly before his mind that the South Island during that era would have presented a very similar appearance; or (he enquires) might it not more appropriately be compared to the inner Thibetan glacier region as it at present exists?"

But differing materially, as we do, both as to the time at which the glaciation in question occurred, and as to the dimensions which it attained, we differ still more widely as to the causes of its origin and subsequent disappearance.

After having stated, as above extracted, the exact character of the glaciation in which he alleges the South Island to have been involved, in pleistocene times, the learned doctor proceeds to give the following as his views of the "causes" which brought it about, and of those which afterwards led to its extinction, heading that part of his report which is specially devoted to this

question with the words "Causes of the pleistocene glaciation of New Zealand." For convenience of future reference I have numbered the several paragraphs as they occur in the report; they are as follows :—

"*Causes of the Pleistocene Glaciation of New Zealand.*

(1.) "During the tertiary period, the Southern Island of New Zealand was repeatedly submerged, and extensive strata of calcareous, tufaceous, and argillaceous sandstones, greensands, marls, limestones, and shale, with beds of lignite, were deposited. The country emerging again, the physical feature was a high mountain chain, plateau-like, but with depressions existing before the tertiary submergence, but now partly obliterated, running generally either on the junction of two formations, on the lines of faults, or on the break of bold anticlinal folds.

(2.) "As soon as the country had risen so high as to reach the line of perpetual snow, the accumulation of névés began, which were the more considerable as glaciers and large rivers had not yet begun their task of ridge making in contradistinction to the action of waves and currents of the sea on submerged lands, which tends to wear off all eminences, filling the submarine valleys with the débris.

(3.) "The configuration of the area now forming the Canterbury plains would have been a broad arm or channel of the sea running along cliffs of tertiary rocks from Timaru to Double Corner, and surrounding Banks Peninsula as an island. The waters derived from atmospheric sources had already begun, during the emergence of the land, to open an outlet for themselves from the higher regions by clearing the natural watercourses, but had only in a minor degree attacked the tertiary strata, filling the valleys in favourable localities as high as 4000 feet above the level of the sea.

The névés, considering the insular and peculiar position of New Zealand—its principal range or back-bone running from S.W. to N.E., thus lying at a right angle to the two prevailing air currents, the equatorial north-west and the polar south-east, both bringing moisture with them—would soon have attained an enormous extent, and would have considerably lowered the line of perpetual snow, even had not the land been raised to a higher elevation than at present. The consequence would have been that glaciers of much larger extent would have descended down the natural outlets, grinding down the rugosities of bottom and sides.

(4.) "The action of the glaciers beginning to lay open the rocks of the higher ranges, would soon offer sufficient material for moraine accumulations, first on the glaciers themselves, and afterwards at their terminal faces.

(5.) "The scooping action of the ice having once begun to eat into the plateau-like range, not only in the main course of the glaciers, but also in the

lateral valleys becoming more extended from day to day, would furnish more and more material for the formation of huge moraines.

(6.) "Let us now consider what may have been the action of the waters during the emergence of the island upon the region over which at present the Canterbury plains extend.

(7.) "In the first instance the waves of the sea would have acted upon the tertiary strata, undermining and destroying them, till the débris of the falling cliffs would have formed a protecting wall at their foot, although frequent oscillations and changes in the ratio of elevation or subsidence may have caused many diversities.

(8.) "The tertiary beds, risen above the level of the sea, would soon have been eroded by the action of the streamlets or torrents descending from the higher regions, and growing larger with the continuance of the upheaval and becoming more numerous, bringing down with them gravel and sand, more effectually increasing their eroding power.

(9.) "At the same time the glaciers, descending from the enormous snow fields, covering the large plateau-like ranges, began to fill all the existing valleys to the plains in a fan-like shape.

(10.) "Of this occurrence, however, we have very little proof, if it be not that the older glacial deposits in the bed of the Rangitata, several miles below the gorge, and some others rising above the plains, between the Malvern Hills and the Waimakariri, belong to that period.

(11.) "High on the ranges, near the plains, the proofs of still greater glaciation of the island are visible in the inworn sides; even the ranges themselves, in their summits and configuration, bear distinctly marks that their very form is attributable to such an almost universal glaciation. Moreover, it is evident, by judging from the study of our present glaciers, that these enormous névés, and ice masses, covering with an uniform sheet the higher regions of the whole island, would not offer much material for the formation of the plains till the glaciers had begun their task of ridge-making, which took place principally in the second epoch of the glaciation of this island.

(12.) "The glaciers had so far retreated that they were only confined to the principal valleys, and of these such clear signs are found, as soon as we enter the valleys between the ranges leading from the Canterbury plains into the Southern Alps proper, that their power and its effects are unmistakable. And as now these glaciers, as shown above, brought a much greater amount of débris from the disintegration, destruction, and weathering of the mountains with them, they did not form only enormous moraines at their sides and their terminal end, but the torrents issuing from them carried down a great amount of material in the form of boulders, shingle, sand, and glacier mud, the latter being derived from the triturating effects of the ice on the sides and bottom of

the channel of the glaciers. These torrents now began to raise rapidly their beds, and filled, by the continuous shifting of their regular and flood channels, all the inequalities of the surface of the lower regions exposed by the emergence of the sea. *From that moment the formation of the Canterbury plains began.*

(13.) "Moreover, a momentum of high importance must not be lost sight of, namely, that all the rivers which traverse the Canterbury plains have their sources in formations which consist principally of shingle and sand-making rocks, thus affording all the necessary elements for effecting this purpose.

(14.) "Ascending the Canterbury plains we can easily trace their continuation up the valleys, the angle of the dip of the loose deposits rising the more we approach the terminal moraines of these pleistocene glaciers. Amongst those which form our plains, I have traced all the principal ones, and I shall give in the sequel the length and the position of their terminal face.

(15.) "It will be seen by that list that at least two of those glaciers (not yet having examined the upper valley of the Waimakariri) were so large that they sent side branches into the valley of the Ashburton, so as to form in that valley one of the largest ice streams of the whole system, which thus gives the key to some peculiarities of the Canterbury plains, and which, without the knowledge of this important fact, would be very difficult to explain."

The foregoing paragraphs contain all that is to be found in the report in question, or, indeed, so far as I am aware, in any of Dr. Haast's writings, as to the cause of the alleged pleistocene glaciation of New Zealand, although its existence and extent, as stated in this report, have been constantly referred to and assumed as proved, in his subsequent papers upon the geology and physical geography of the South Island. I therefore thought it proper to quote these passages at full length, in order not only to prevent any suggestion of misinterpretation, but also to ensure a more complete understanding of the criticisms which I propose to apply to the propositions deducible from them. At first blush, indeed, it seems difficult to believe that Dr. Haast really intended his readers to accept the statements contained in these passages in their plain literal sense, inasmuch as the geological and other physical changes which he has crowded into the pleistocene period are of astonishing magnitude, more especially when we bear in mind that New Zealand is separated from the nearest continental land, from which it could draw any portion of its present organic features, by not less than 1200 miles of ocean. But the language is too clear to permit of any other than the literal sense, and, therefore, I have been compelled to adopt that sense in dealing with the questions under discussion. Now, upon a careful consideration of the above quoted passages, we find that certain propositions, in the nature of postulates, are laid down

for our acceptance, which, so far as they are material for the purposes of my own argument, may be briefly stated as follows :—

1. That the Southern Island of New Zealand was repeatedly submerged during the tertiary period.

2. That its ultimate re-emergence took place at the close of that period, and that it gradually assumed the appearance of "a high mountain chain, plateau-like, but with depressions existing before the tertiary submergence, which were then partly obliterated, running generally either on the junction of two formations, on the lines of faults, or on the break of bold anticlinal folds." So far as I can comprehend all this, I assume it to mean, that the re-emerged land, limited in the first instance to the area of the present mountain range, exhibited the aspect of a plain of marine denudation ; that the surface irregularities which had existed prior to its latest submergence had been partly obliterated by submarine denudation ; and that, as the land rose *en masse*, it assumed the appearance of a flat-topped mountain range, protected, in great measure, from ordinary terrestrial denudation by a pall of perpetual snow extending to the water's edge.

3. That, "looking to the insular and peculiar position of New Zealand, the névés" (by which, I presume, Dr. Haast means mere accumulations of snow, without the ordinary technical sense in which the word is used) "soon attained an enormous extent, and considerably lowered the line of perpetual snow." Leaving the first part of this proposition for future comment, I must confess my inability to comprehend how accumulations of snow, however enormous, can lower what is generally understood as the snow line, and it becomes, in the present instance, the more difficult to comprehend, for, as we have seen, Dr. Haast leads us to understand, by comparing his asserted glaciation with that of Greenland, etc., that the snow line at the time in question was coincident with sea level.

4. That as a result of the suggested elevation, and of the operation of the so-called "causes" above quoted, the islands of New Zealand became involved, in pleistocene times, in a glaciation similar to that which now invests Greenland and the antarctic lands, or the inner Thibetan glacier region.

5. That when the land of the South Island had risen so high as to reach the line of perpetual snow, "the configuration of the area now forming" (doubtless "occupied by") "the Canterbury plains would have been a broad arm or channel of the sea, running along cliffs of tertiary rocks from Timaru to Double Corner, and surrounding Banks Peninsula as an island."

It will, of course, be seen that this latter proposition conflicts in some degree with those which purport to define the character of the suggested glaciation, as mentioned in the foregoing quotations from the report, for it would seem to involve an implication that the "line of perpetual snow" stood

somewhere above, instead of being coincident with, sea level. But, although I am unable to reconcile the apparent discrepancy, I have thought it necessary to call special attention to this particular proposition, as it contains an admission of considerable importance to my own arguments.

Such, then, are the propositions which Dr. Haast lays down for our acceptance, without, however, condescending to offer any arguments in support of them, or to state any relevant facts from which they could be independently deduced, and I need not say how unfortunate and embarrassing this is in connection with any discussion of the questions at issue between us. In a scientific enquiry "a point which can be proved should not be assumed," and it was Dr. Haast's undoubted duty, when laying down such propositions as those which are fairly deducible from his report, to have stated, clearly and definitely, the nature of the evidences which had led him to adopt them. But, notwithstanding these disadvantages, and in spite of the difficulty of assigning any meaning which should be consistent with received geological principles to much of his language, I propose to examine the above stated propositions at some length. In the first place, however, in order that the character of the glaciation with which Dr. Haast has chosen to invest the islands of New Zealand in pleistocene times may be understood, I extract the following descriptions of the present glaciation of Greenland, and of that of the antarctic lands, from authors of undoubted authority :—

"Whatever it may have been when Captain Inglefield saw it a year ago," says Dr. Kane, speaking of Greenland even before the close of the northern summer, "the aspect of this coast is now most uninviting. As we look far off to the west, the snow comes down with heavy uniformity to the water's edge, and the patches of land seem as rare as the summer's snow on the hills about Sukkertoppen and Fiskernaes. All the back country appears one great rolling distance of glacier."

Mr. Geikie, in his work on "The Great Ice Age," page 54, thus speaks of the existing glaciation of Greenland :—

"We have now acquired some knowledge that bears upon the origin of the Scottish till, but we shall gather yet further aid in our attempts to decipher the history of that deposit by taking a peep at some arctic country. For this purpose we cannot do better than select ice-covered Greenland. That desolate region of the far north, despite the bleak and barren aspect of its coasts, and the horrors of the ice-choked seas that must be traversed to reach its more northern shores, has nevertheless been frequently visited by daring navigators, who have pushed their investigations many hundred miles north of the Danish settlements. The accounts which they give are chiefly taken up with descriptions of the wild ice-bound coast of Greenland, few attempts having been made to penetrate into the interior. But that cannot be said to be altogether a terra

incognita, for although it has never been and probably never will be traversed, yet enough is known to leave us in little doubt as to the general character of these unvisited desolations. The western shores of Greenland have been traced northward from Cape Farewell, in the latitude of the Shetland Islands, to beyond the eightieth parallel. The eastern and north-eastern coasts have not been so continuously followed, but our knowledge of these has been considerably increased during recent years, thanks to the exertions of German and Swedish geographers. The superficial area of Greenland cannot be less than 750,000 square miles, so that the country is almost continental in its dimensions. Of this great region only a little strip, extending to 74° north latitude, along the western shore is sparsely colonised; all the rest is a bleak wilderness of snow and ice and rock. The coasts are deeply indented with numerous bays and fiords, or firths, which, when traced inland, are almost invariably found to terminate against glaciers. Thick ice frequently appears too, crowning the exposed sea cliffs, from the edges of which it droops in tongue-like and stalactitic projections, until its own weight forces it to break away and topple down the precipices into the sea. The whole interior of the country, indeed, would appear to be buried underneath a great depth of snow and ice, which levels up the valleys and sweeps over the hills. The few daring men who have tried to penetrate a little way inland from the coast, describe the scene as desolate in the extreme—far as eye can reach nothing save one dead, dreary expanse of white. No living creature frequents this wilderness —neither bird, nor beast, nor insect—not even a solitary moss or lichen can be seen. Over everything broods a silence deep as death, broken only when the roaring storm arises to sweep before it pitiless blinding snow."

As regards the antartic lands, Mr. Geikie says, at page 101 of the same work:—

"Sir J. C. Ross' striking account of the mighty ice sheet under which the Antarctic Continent lies buried, gives one a very good notion of the kind of appearance which the skirts of our own ice sheet presented. After reaching the highest southern latitude which has yet been attained, all his attempts to penetrate further were frustrated by a precipitous wall of ice that rose out of the water to a height of 180 feet in places, and effectually barred all progress towards the pole. For 450 miles he sailed in front of this cliff, and found it unbroken by a single inlet. While thus coasting along, his ships (the Erebus and Terror) were often in danger from stupendous icebergs and thick pack ice that frequently extended in masses too close and serried to be bored through. Only at one point did the ice wall sink low enough to allow of its upper surface being seen from the masthead. Ross approached this point, which was only some fifty feet above the level of the sea, and obtained a good view. He describes the upper surface of the ice as a smooth plain shining like

frosted silver, and stretching away far as eye could reach into the illimitable distance. The ice cliff described by Ross is the terminal front of a gigantic mer de glâce, which, nurtured on the circumpolar continent, creeps outward over the floor of the sea until it reaches depths where the pressure of the water stops its further advance by continually breaking off large segments and shreds from its terminal front, and floating these away as icebergs."

Mr. Darwin, speaking of islands far to the north of the South Polar continent, tells us (at page 248, tenth thousand of the Naturalist's Voyage), that, "considering the rankness of the vegetation in Terra del Fuego, and on the coast northward of it, the conditions of the islands south and south-west of America is truly surprising. Sandwich land, in the latitude of the north part of Scotland, was found by Cook, during the hottest month of the year, covered many fathoms thick with everlasting snow, and there seems to be scarcely any vegetation. Georgia, an island ninety-six miles long and ten broad, in the latitude of Yorkshire, in the very height of summer is in a manner wholly covered with frozen snow. It can boast only of moss, some tufts of grass, and wild burnet; it has only one land bird, yet Iceland, which is 10° nearer the pole, has, according to Mackenzie, fifteen land birds. The South Shetland Islands, in the same latitude as the northern half of Norway, possess only some lichens, moss, and a little grass; and Lieutenant Kendall found the bay in which he was at anchor beginning to freeze at a period corresponding with our 8th of September. The soil here consists of ice and volcanic ashes interstratified; and at a little depth beneath the surface it must remain perpetually congealed, for Lieutenant Kendall found the body of a foreign sailor, which had long been buried, with the flesh and all the features perfectly preserved."

I am not in a position to quote any condensed description of the inner Thibetan glacier regions as they at present exist, nor am I prepared to offer any description of them of my own construction, not having Mr. Godwin Austen's work before me; but, so far as I can recollect, a description of those regions would not materially differ, as regards the glaciated aspect of the country, from those which I have already extracted in relation to Greenland and the antarctic lands, and it would certainly be less applicable than they are, to the glaciated aspect of an island in which the ice sheet was bounded only by the waters of the sea.

Now, it will at once be seen that, if the statements made and the picture drawn by Dr. Haast respecting the glacial condition of New Zealand in pleistocene times be founded in truth, the deposit and accumulation of snow, and the formation of glaciers upon the newly-emerged land of the South Island, must have commenced very soon after the land had risen above sea level. That this is, in effect, Dr. Haast's own conception is shown by the

language of the 8th and 9th paragraphs above quoted, although in the latter he certainly mentioned "plains," the formation of which, however, had not even commenced at that time, if we are to rely upon the statements in paragraphs numbered 3 and 12.

But before proceeding with the more full consideration of the suggested glaciation, I propose to deal with the first and second propositions above stated. In doing so, following in this respect the course adopted by Dr. Haast himself, and giving him the advantage, for the present, of leaving the North Island altogether out of the discussion, I intend to limit myself to a consideration of the physical features of that part of the South Island which is comprehended within the original boundaries of the Province of Canterbury, for it will have been noted that, although Dr. Haast speaks of his supposed glaciation as having involved *the whole of New Zealand*, his report does not contain a single reference to any part of it outside of the special district above mentioned.

Now, a glance at any map of the South Island, indicating its political divisions in 1864, will show that the district referred to is traversed from north to south by the central portion of the great mountain range which occupies the western side of the island, and that near the southern extremity of the district this range culminates in Mount Cook, estimated at upwards of 13,000 feet in height, whilst it has, otherwise, an average general elevation of from 8000 to 9000 feet. At the distance of about thirty-five miles to the eastward from the foot of this main range is Banks Peninsula, a volcanic mass, stretching from west to east some thirty miles, with an average breadth of thirteen to fourteen miles, its highest summit being, I believe, 2800 feet above sea level, whilst the average general elevation does not exceed 1800 feet. This mass of hills contains numerous bays, inside of which the slopes are usually very steep, constantly presenting abrupt escarpments.

Stretching from Timaru in the south to Double Corner in the north, a distance of about 130 miles, interrupted only at its junction north and south with the western end of Banks Peninsula, we find a low coast line, between which and the base of the great mountain chain lie the Canterbury plains, which rise gradually from sea level until they reach, at the foot of the mountains, an elevation varying from 800 to 1000 feet—in this respect presenting very much the character of the talus-like plains of Chili, as described by Mr. Darwin in his notes on the geology of South America. Traversing these plains from west to east are five large rivers, named the Rangitata, Ashburton, Rakaia, Waimakariri, and Ashley, which, with their tributaries within the range, effect the entire drainage of the eastern side of the main chain for a length of about 150 miles, their falls, for the greater part of the distance through the plains, averaging twenty-eight feet per mile.

These rivers are liable to great floods, arising from causes similar to those which affect the head waters of the Rhone, and the quantity of shingle and silt which they then carry to sea is enormous. The plains are composed of river alluvium, in a deposit which is evidently of considerable thickness, for, except at points where the larger rivers which traverse them have cut through these deposits near their own debouchures from the mountain range, the foundations upon which they lie are nowhere observable.

As will have been noticed, Dr. Haast speaks of the surface materials composing these plains as covering the foundations upon which they lie, with an almost uniform gradient, which I have assumed to mean, that their surface slopes almost uniformly from the most elevated parts near the foot of the mountains to the level of the sea, a point of great importance in connection with any enquiries into the manner in which these deposits were originally spread over the area which they now occupy. The character of the country, both in the neighbourhood and to the southward of Timaru, is sufficiently given in an extract from another report of Dr. Haast's, which will be found in the sequel, and, therefore, need not further be referred to here.

As regards the indigenous vegetation of the district under consideration, I may state, generally, that, with the exception of occasional but by no means common or extensive patches of forest, its eastern side (taking from the summit of the dividing range) supports only grasses and other herbaceous plants, whilst the whole of its western side, below sub-alpine level, is densely clothed with luxuriant forest. The surface of Banks Peninsula is pretty evenly divided between grass and forest land, the latter probably predominating. The flora of the South Island is somewhat less rich in genera and species than that of the North Island, and would, probably, not yield more than 750 species of flowering plants, of which one-fifth would be common to New Zealand and Australia, and one-tenth to New Zealand and South America, whilst not less than 500 species would be peculiar to New Zealand. But it must also be borne in mind that the major part of the flora has a semi-tropical aspect, inconsistent with the probability of its co-existence with severe glacial conditions, many of the most hardy plants being unable to withstand the rigour even of an English winter.

As is well known, the terrestrial fauna of New Zealand consists almost exclusively of birds, and of the 150 species which may be considered as truly belonging to New Zealand, there are but few which are not found in the South Island. Amongst those which occur there I may particularly mention the two species of wingless birds peculiar to the South Island, namely, *Apteryx oweni* and *Apteryx australis*, as well as the *Ocydromus australis*, and the singular *Stringops habroptilus*, in the first of which the wings are incomplete, and in both are useless for purposes of flight. I must also, in this connection, mention

the now extinct *Dinornithidæ*, of which Dr. Haast himself assures us that a large number of species existed during pleistocene times. The climate of the South Island is remarkably good, every species of temperate fruit and a large number of plants which require to be cultivated under glass in England flourishing luxuriantly.

Such are the existing surface features of a tract of country which, if we are to believe Dr. Haast, was subjected, in very recent geological times, after repeated submergences, and when (as he assures us) its elevation above sea level was much less than it is at present, to a glaciation as rigorous as that of Greenland and the antarctic lands.

Returning now to the quotations already made from the learned doctor's report, let us enquire more closely into the geological and other changes which he calls upon his readers to believe that the district in question has undergone since the close of the tertiary period. In the first place, we are told that the whole South Island has risen not less than 13,000 feet above sea level; then, that almost immediately upon and during the continuance of its emergence it became subjected to, and then remained for a large though indefinite period involved in, a glaciation of the character already frequently alluded to; and, lastly, we are required to believe, that it must have acquired all its present surface conditions within the same period. And yet, in the teeth of all this, and in spite of the assertion in paragraph 3, that during the progress of the alleged glaciation "the configuration of the area now occupied by the Canterbury plains must have been a broad arm or channel of the sea, surrounding Banks Peninsula as an island," the learned doctor has, in a recent address, as President of the Philosophical Institute of Canterbury, whilst reaffirming in its entirety the report of 1864, absolutely repudiated all idea of elevation of the area occupied by the Canterbury plains, either during his glacial period, or during post-pliocene times generally. His language is as follows:—

"If elevation had taken place during the postpliocene or glacier period, Banks Peninsula would certainly show this most conspicuously; but what does a close examination of that interesting isolated volcanic region reveal to us? We observe no trace of marine action, except the result of a slight oscillation of about twenty feet, by which the peninsula has been raised after undergoing probably a similar submergence. It is true that its lower portion in several localities, up to 800 feet, is covered more or less with silt—a fine loam—which, in many instances, is a true slope deposit, partly derived from the decomposition of the rocks in sitû, or partly brought down from higher regions by running water. Moa bones and pieces of small land shells have been found in these deposits, of which there are many splendid sections to be examined, but nowhere the least sign of marine life could be detected in them. This fact alone shows that the emergence theory has not the least foundation;

on the contrary, from the nature of these silt beds and their partial denudation, we might conclude that the peninsula has undergone a depression since they were deposited. Had a rise of the ground taken place, by which the Canterbury plains had emerged from the sea, we certainly would find the proof of it along the slopes of the peninsula, in the form of raised beaches, deposits of sea shingle, and sand with recent marine shells, but nowhere is a trace of such easily recognisable beds to be found, and thus, even assuming that the clear and undeniable data which the Canterbury plains present as to their origin were not in existence, the character of the silt deposits on the slopes of Banks Peninsula, and the absence of recent marine beds, would at once compel us to reject Captain Hutton's new theory as incorrect in all the issues."

In view of the statements contained and the theory propounded in the report of 1864, all this is very incomprehensible, for if no elevation has taken place, even since the period when the configuration of the area now "occupied by the Canterbury plains was a broad arm or channel of the sea," I would ask the learned doctor to account for the astonishing fact, asserted by himself, that the higher parts of the foundations upon which the surface materials of these plains are deposited, "consisting," to use his own words, "of palæozoic, volcanic, and tertiary rocks, which, prior to the postpliocene elevation of the land, composed the former sea bottom," happen now to be exposed at the debouchures of the great rivers which traverse the plains, at an elevation varying from 800 to 1000 feet above the level of the sea, towards which the superimposed materials slope "with an almost uniform gradient"?*

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* Since the foregoing paper was read, my attention has been called to the following passages, the first in Dr. Haast's recent address, and the second in a report on the geology of the Canterbury plains, presented by him to the Superintendent of Canterbury in 1862:—

Extract from Address.

"But a still more formidable objection to Captain Hutton's hypothesis presents itself: If the Canterbury plains were of marine origin, the beds of which they are composed would have preserved some traces of it; but, although we have clear sections, several hundred feet high, in almost every river, their fluviatile character is unmistakable. The boulders, shingle, gravel, sand, and ooze are all deposited as a river torrent would place them, according to their form and size, and according to the greater or less amount of water being brought down. The peculiar character of surf shingle is nowhere exhibited, but all the pieces of stone have the subangular form so peculiar to river shingle. Marine fossils are missing throughout."

After referring to the circumstance that, at the foot of the Urunui Mountains forming the Southern Alps, large deposits of boulders would necessarily occur, he says:—"The Canterbury plains, formed by these deposits, are 112 miles long and on an average 24 miles broad, and consist for some miles inland, along the coast line, of alluvium brought down by the rivers which intersect these plains, and which, for about ten miles from their mouths, flow above the present level of the plains, resembling in this respect the Adige and the Po.

"About nine or ten miles from the mouths of the rivers a change occurs, and, although the beds of the glacial streams are still broad, they begin to cut into the loose deposits of the plains. Terraces are formed, which, on the eastern side of the plains, near the base of the mountains, are often 300 feet above the level of the rivers, and consist of from four to six distinct and perfect terraces rising one above the other. At

But, singular and contradictory as this may appear, it would seem that Dr. Haast's recent repudiation of any elevation of the land in pleistocene times is not new, as may be inferred from the following passage, which occurs at page 22 of the report in question :—"During the greatest depression of the island in the post-tertiary era, there was doubtless a narrow arm of the sea, which ran along the western foot of Banks Peninsula, and of which we have ample evidence in raised beaches near it." But the doctor limits the extreme height of these raised beaches to twenty feet above sea level. Now, although the utter discrepancy between the statements contained in the last quoted paragraph and those which occur in the passages which profess to give the "causes" of the alleged glaciation would almost justify us in treating the whole of Dr. Haast's propositions as untenable, I think it as well to show, partly by reference to his own writings on other occasions, and partly by independent facts, how utterly unfounded it is under any system of interpretation which can be adopted. In 1865, the year after the date of the report from which I have already quoted, Dr. Haast reported to the Provincial Government of Canterbury on the structure of the Timaru district, with special reference to the probability of obtaining a supply of water in that locality by means of artesian wells. In this report he says :—

"The town of Timaru is situated on the eastern end of a dolerite plateau, which stretches from Mount Horrible, * * for ten miles to the sea, with a breadth of about six miles, between the northern bank of Pig-hunting Creek to the south, and the Washdyke Creek to the north.

"The existence of this dolerite sheet is the cause of the configuration of the Timaru roadstead, and of the preservation of the loose pleistocene strata lying upon the volcanic rocks, which otherwise, like similar strata to the north and south of Timaru, would probably have been destroyed by the great

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sudden curves in the rivers (which shift their channels with almost every heavy fresh) these terraces are often destroyed, and beautiful vertical sections are exposed, showing clearly the nature of the deposits by which they have been formed. There is, in the first place, generally a capping of well-stratified shingle and sand sloping insensibly to the sea; below this we find different beds of boulders, for the greater part rounded, but sometimes angular, interstratified with sand, loam, and clay, exactly resembling the boulder-clays of Europe. These beds are generally quite horizontal, but are sometimes irregularly disturbed, as if tilted up by the stranding of an iceberg. *In the shingle-clays*" (the italics are mine), "*which sometimes thin out in a distance of fifty or sixty yards from three to four feet to a few inches, I observed the remains of some exuviæ and bivalve shells, but so rotten that it was not only impossible to remove them, but even to ascertain the species; although I believed one of them to resemble the* Venus intermedia *of our seas.*"

He further says :—"During a careful examination of the boulders forming these deposits, I was not able to detect any eruptive or volcanic rocks or debris of the tertiary deposits at the base of the latter, but only the different sandstones, slates, flagstones, pebble beds, and conglomerates which form the Southern Alps; whilst the rivers flowing through these zones now bring down a great quantity of volcanic detritus, *from which we may conclude*" (the italics again are mine) "*that when these deposits of the glacial period were formed, the volcanic mountains* (*never more than* 5000 *feet, and generally* 3000 *to* 3550 *feet high*) *were lying below the level of the sea.*"

18th February, 1875. W. T. L. Travers.

glacier rivers in later pleistocene times. We must not, however, lose sight of the fact that as apparently none of those coming from the central chain reached the sea in this district, another favourable circumstance was added for the preservation of the estuary and fluviatile deposits, lying upon the dolerite, as well as of the loose young tertiary strata immediately below it.

"This dolerite plateau begins on the summit of Mount Horrible, the slopes of which, towards the Pareora and its northern tributary, are very steep and precipitous. The flat summit, consisting of dolerite identical with that of Harper's Hills in the Malvern Hills, forms vertical escarpments for about 100 to 150 feet, from the numerous fissures of which a fine vegetation grows, giving additional beauty to the picturesque scenery. A deep and straight valley runs here, as in the Malvern Hills, west of this great escarpment, suggesting at once that these dolerites deposited on the bottom of the sea were ejected by a longitudinal fault or fissure in the tertiary strata by which the valley is bounded on both sides. This valley, at the junction with the Pareora, is, according to barometrical measurement, 312 feet above the level of the sea, whilst the highest summit of Mount Horrible reaches to an altitude of 1138 feet.

"The capping of dolerite forms generally a horizontal sheet on that summit, although at some localities a dip towards east of as much as ten degrees at the edge of the escarpment may be observed.

"In travelling eastwards, after half-a-mile, the horizontal line of the dolerite changes, and the mountain begins to have a small slope, which is greatest above Mr. King's shepherd's hut, the foot of Mount Horrible being in fact situated here. This shepherd's hut, distant about seven miles from Timaru, lies 686 feet above the level of the sea."

"Here at this shepherd's hut begins, properly speaking, the dolerite plateau, overlaid by silt, sloping at an almost uniform angle to the sea, and showing dolerite rocks in some gullies only, which have their beginning either in the eastern slopes of Mount Horrible, or even on the plateau itself for the surface drainage of the ground; but notwithstanding their local origin, the latter have been able not only to denude the loose silt deposits near the surface, but also to cut through the dolerite sheet into the looser tertiary strata beneath. This occurrence gave me an opportunity to convince myself that, as far as I was able to judge, only one large sheet was spread on that plateau, which with a slight gradual slope dipped towards east, whilst it had a nearly horizontal extent towards north and south, the fall being, as it seems, very slightly towards both directions. The fall for the last seven miles being only about 90 feet in the mile, or one foot in 58, the inclination is almost imperceptible.

"At the same time I became conscious of another fact, namely, that the dolerite stream as it advances towards east thins out so as to be, in some

places in the cliffs of Timaru, only four feet thick, but still exhibiting well, as I shall show in the sequel, the peculiar nature of these beds. This regularity is very striking and is of the highest importance, as it shows us, that since the deposition and cooling of that dolerite sheet, no disturbance, except a gradual slow upheaval of the country, has taken place, although other proofs are not wanting to demonstrate clearly that minor changes have occurred, and that the present configuration of the surface, near and in Timaru, is not at all in accordance with that which the dolerite below presents. There is no doubt that most of the many spurs which intersect the Timaru plateau in all directions, although all leading towards the sea, have been formed by the present surface drainage since the last silt covering was deposited."

"I shall now proceed to give some details concerning the nature of the cliffs which form the Timaru roadstead, as they will assist in following the deductions at the end of this report, based upon the results obtained during this survey.

"The cliffs south of the landing place consist entirely of silt, forming banks often 50 to 60 feet high; but as, besides the occurrence of the dolerite in Saltwater Creek (Otipua) and Pig-hunting Creek, near the sea, the Patiti Reef shows these loose banks have been protected by the dolerites, which form here reefs in the sea, and which have broken, and are still breaking, the force of the waves and currents. After having passed the landing place, where I had an opportunity of examining the silt in the new cutting, giving a vertical section of about 25 feet, we reach the first bed of rocks."

"The rock, for a thickness of about 10 to 12 feet, is here visible, and consists of large blocks, being irregularly joined, which has been without doubt the effect of cooling. These joints are filled with silt, often hardened and ferruginous, as if it had been deposited during the cooling of the rock, so that the heat had been sufficient to produce some change in it."

"Advancing towards the north we pass to the next cliff, which consists entirely of silt, being at its northern end near the lagoon about 30 feet high. No fossils of any kind rewarded my search; and only in one locality the uniformity of this deposit was broken by the occurrence of a layer of white fine silt of about a foot in thickness, 12 feet above the sea level, interstratified with the yellow coarse silt, and having somewhat the appearance of glacier mud, being almost impalpable."

At "Pig-hunting Creek * * the dolerites are only confined to its northern bank until it approaches the slopes of Mount Horrible, where again the rocks are exposed on both banks. Following the dolerite sheet of Timaru to the summit of Mount Horrible, we at once observe that it becomes thicker the more we advance towards that mountain, and, as the beautiful vertical precipice at its western termination shows, is here of a thickness of

more than 100 feet. Descending that mountain in a westerly direction, which, with horses, is rather a difficult task, we find below the dolerite the same burnt tufaceous beds as in the Harper Hills and the beach at Timaru; but afterwards for 300 feet no indication whatever of the nature of the strata is to be met with, till, at an altitude of 650 feet, another dolerite stream makes its appearance, which is of a more compact character than the uppermost or Timaru sheet.

"This stream overlies beds of a calcareous or marly nature, identical with those of the Curiosity Shop of the Rakaia, and of a middle tertiary age."

"In summing up (he says) it will be palpable that no link in the evidence before us is wanting to come to a conclusion.

"1. In the middle tertiary epoch, extensive strata of calcareous or argillaceous beds were deposited in this locality *on a deep sea bottom** having an almost uniform slope towards the east.

"2. Some of these beds, by their lithological character, are impermeable to water, being at the same time interstratified with permeable strata.

"3. Submarine eruptions of dolerite took place, which, spreading over the sea bottom, covered the first named tertiary strata, protecting them at the same time from denudation.

"4. Between these eruptions subsequent tertiary beds were also deposited, which, by repeated eruptions of dolerite, were also preserved.

"5. Some of these younger beds present us with the same characteristics as described in No. 2.

"6. The dolerite sheet on the summit of Mount Horrible" (which he states to be now 1138 feet above sea level), "which can be followed from there to the sea *was the last deposited on the sea bottom.**

"7. This sheet, by flowing towards east, where it terminates, becomes gradually smaller and thinner.

"8. Since the deposition of this latter sheet, only minor changes took place, of which several old river channels now covered by silt, and as shown by the wells in Timaru, are witness." (It will be observed that Dr. Haast treats an elevation of a deep sea bottom to the height of 1138 feet at least above sea level as a "minor change" only.)

"9. That occurrence at the same time proves the oscillation of the ground, but the upward motion was predominant.

"10. Finally, no signs of any disturbance, since the deposition and rise above the sea of the different levels alluded to, have been observed; so that by boring or sinking they will be found in their natural position."

* The italics are mine.

I have been obliged to extract somewhat at length from this paper, but it will be observed that the whole extract bears materially upon the questions at issue. If I read it rightly, the following conclusions appear to be fairly deducible from his language :—

1. It being stated that the upper capping of dolerite on Mount Horrible is 1138 feet above sea level, and that it was deposited upon a sea bottom composed of "younger pliocene strata," it is evident that the rise in the land at this point, since this dolerite sheet was deposited, must have exceeded 1138 feet.

2. That looking to the alleged steepness of this dolerite sheet below the summit of Mount Horrible, and to the fact that the entire surface must have continued for a very long period as bare rock, exposed to the full swing of the Pacific Ocean, the conditions it offered were most unfavourable to its colonization by a marine fauna, except such as could resist the impact of the Pacific waves, and that, therefore, it is in no degree surprising that the "silt" which is described by Dr. Haast as covering this sheet in diminishing thickness from the foot of Mount Horrible to the present sea cliffs should not contain ordinary littoral remains.

3. That as the "silt" which covers this dolerite sheet, and which is spoken of by Dr. Haast as of pleistocene age, is found to have filled up all the hollows and depressions in it (as seen especially in the cliffs near the present sea shore), often to a depth exceeding fifty feet, and to extend back in diminishing thickness to the foot of Mount Horrible, this silt, as well as that on Banks Peninsula, which Dr. Haast calls "a slope deposit," must be considered as having been deposited in standing water, notwithstanding the alleged absence of shells. It must be borne in mind that the mere absence of fossils is not sufficient to prove the purely terrestrial origin of such a deposit. The physical evidence must not be ignored, and when that evidence is clearly irreconcilable with any supposition other than that the deposit in question took place below the surface of standing water, the negative evidence afforded by the absence of traces of aqueous life, even in situations otherwise favourable to its existence and preservation, must be rejected.

The silt spoken of by Dr. Haast as occurring at Timaru and at Lyttelton presents, in both situations, distinct traces of stratification. At Lyttelton it attains, in many places, a thickness of upwards of 100 feet close to the level of the waters of the harbour, the bed of which is composed of precisely the same material. At the immediate shore line this silt exhibits, wherever it has been exposed to wave action, nearly perpendicular cliffs, resting on exposed lava beds; that portion of the silt which formerly completed the slope from the top of the cliff to the bed of the harbour having been removed by the waves. In sheltered situations the slope is still continuous, but the upraised portions show

no signs of imbedded shells. Indeed, Lyttelton harbour is singularly destitute of marine shells, except such as live in rocky situations, the silt in the harbour consisting of mud so soft that a wooden rod will sink many feet into it by its own weight.

It is remarkable, moreover, that in the Timaru beds, at the height of 650 feet above sea level, Dr. Haast observed a lower dolerite sheet underlying the above mentioned younger pliocene beds, and covering fossiliferous beds of lower miocene age; and equally remarkable that a prolongation of the gradient at which these lower fossil beds rise from sea level at Timaru would, at the same distance from the sea shore as certain fossils beds which are exposed at the Rakaia, carry them to about the same altitude above that level. These Rakaia beds are also of lower miocene age, and it may, therefore, be assumed that the beds covered by the lower dolerite sheet must have been above sea level during a greater part of the interval between that epoch and the occurrence of some depression during which the newer pliocene beds which overlie this lower dolerite sheet were deposited. I have reason, however, for believing that the beds which Dr. Haast has called "newer pliocene" are in reality of miocene age, and if this be the case, then my own views are further strengthened, as this fact would indicate clearly the absence of any pliocene beds in the district in question. I might quote, from many other papers of Dr. Haast's, statements irreconcilable with the views contained in his report of 1864, but I prefer proceeding to the consideration of independent facts bearing upon this part of the subject.

The accuracy of Dr. Haast's statement, "that the greatest height to which raised beaches occur on the eastern side of the Province of Canterbury does not exceed twenty feet," is impugned by Captain Hutton, who informs us of the existence of raised beaches, examined by himself, on the eastern side of the island, not far to the north of the coast line of the Canterbury plains, extending to upwards of 300 feet above the present sea level; whilst he also gives reasons for believing that deposits which occur upwards of 1000 feet above it are also of recent marine origin. The former fact alone, however, would be sufficient to dispose of Dr. Haast's assertions, and the mere negative evidence afforded by the non-discovery of littoral shells amongst the materials of the Canterbury plains cannot outweigh them for a moment. Nor can I conceive that even Dr. Haast himself would venture to assert that his examination of the Canterbury plains—the materials of which below the surface are only exposed in the courses of the great rivers—has been sufficiently exhaustive to preclude the possibility of the existence of shell deposits in any part of them. I may urge, moreover, that the discovery of beds of sea shells amongst such materials as those which compose the major part of the plains—exposed as they must have been, if distributed by marine agency, during the

period when the area which they now cover was "a broad arm or channel of the sea" to the full swing of the Pacific waves—would be very singular, for Dr. Haast tells us that these waves were, at that time, sufficiently powerful completely to undermine and destroy tertiary strata bounding the area in question, and extending from Timaru to Double Corner.

Further, these gravels have been subjected for countless ages to the action of rain water percolating through them, which would, in all probability, have removed any traces of comminuted shells, even had the quantity originally been large. At the present time shells are rarely found upon any part of the Canterbury coast line which is exposed to the surf, and but few are found, and those only of comparatively fragile kinds, even within the area protected from its action by Banks Peninsula. It must further be noted, too, that the materials of which a large portion of the surface deposits of these plains is composed are such as would, in the lapse of geological times, be converted into very coarse sandstones and conglomerates, formations in which the preservation of shell deposits is but little looked for.

But, leaving this matter, I now propose to deal with the probability of the alleged glaciation of New Zealand, judging of such probability from the direct "causes" which Dr. Haast has assigned for it. It will have been observed that these so-called "causes" are, in effect, summed up by the learned doctor in two or three point-blank assertions, unsupported either by argument or evidence; whilst not a tittle of satisfactory explanation is vouchsafed as to the "causes" which subsequently led to its disappearance.

We are told that the South Island was repeatedly submerged during the tertiary period; and that, upon its final re-emergence, snow began at once to accumulate, in enormous quantities, upon the surface, further elevation leading to the formation of large glaciers, which at once began to eat back, I presume, into the plateau-like range of mountains. And the only "causes" actually assigned for the general glaciation which is alleged to have at once supervened, and to have continued for the large but indefinite portion of time occupied in the tremendous upheaval referred to—a glaciation, moreover, which is characterized by the doctor as being similar to that of Greenland and of the antarctic lands, is "the insular and peculiar position of New Zealand, its principal range or back-bone running from south-west to north-east, thus lying at a right angle to the two prevailing air currents, the equatorial north-west, and the polar south-east, both bringing moisture with them."

Dr. Haast gives us no reasons, however, for supposing that the insular or other position of the islands has altered since the times referred to, nor does he suggest any ground, deducible from known physical reasons, why the glaciation he mentions, if it ever existed at all, should not still exist. The winds which then blew are, even according to Dr. Haast, the same as the

prevailing winds of the present day. There is no reason for believing that the moisture they then brought with them was greater than it is now. The country is still high enough, according to Dr. Haast, to produce all the effects assigned to the action of these winds in former times, for in the paragraph numbered 3 he says, in continuation of the passage last above quoted, that "the névés would soon have attained an enormous extent, and would have considerably lowered the line of perpetual snow, *even had the land not been raised to a higher elevation than at present*" (a circumstance which, by the way, he utterly repudiates in his recent presidential address), and, he adds, "the consequence would have been that glaciers of much larger extent would have descended down the natural outlets." Now, assuming that the "causes" mentioned by Dr. Haast would have been sufficient to bring about the suggested glaciation, it is certainly inconceivable, seeing that the same "causes" are still in active operation, why the ice sheet should have melted away.

But Dr. Haast is utterly in error as to the direction of one of the winds which prevail on the coasts of the South Island, and which he describes as the "polar south-east wind." Such a wind, as a surface wind, is entirely unknown in these latitudes, either to physical geographers or to the present inhabitants of the island, and, indeed, its existence is a pure and unwarranted assumption. The prevalent winds of the South Island are the general westerly winds which are laid down on the wind charts of physical geographers as occurring between the thirtieth and sixtieth parallels of south latitude, and are, in effect, the same as the prevalent westerly winds which impinge on the western coast of South America.

Mr. Darwin, speaking of the effect produced by these winds, tells us that "the windy, humid, and equable climate of Terra del Fuego extends with only a small increase of heat for many degrees along the coast of that continent. The forests for 600 miles northward of Cape Horn have a very similar aspect. As a proof of the equable climate, even for 300 or 400 miles still further northward, I may mention (he says) that in Chiloe (corresponding in latitude with the northern parts of Spain) the peach seldom produces fruit, whilst strawberries and apples thrive to perfection. Even the crops of barley and wheat are often brought into the houses to be dried and ripened. At Valdivia (in the same latitude of 40° with Madrid) grapes and figs ripen, but are not common; olives seldom ripen even partially, and oranges not at all. These fruits, in corresponding latitudes in Europe, are known to succeed to perfection. Although the humid and equable climate of Chiloe, and of the coast northward and southward of it, is so unfavourable to our fruits, yet the native forests, from latitude 45° to 38°, almost rival in luxuriance those of glowing intertropical regions. Stately trees of many kinds, with smooth and highly

coloured barks, are loaded by parasitical monocotyledonous plants; large and elegant ferns are numerous, and arborescent grasses entwine the trees into one entangled mass to the height of thirty or forty feet above the ground. An equable climate, evidently due to the large area of sea compared with the land, seems to extend over the greater part of the southern hemisphere, and, as a consequence, the vegetation partakes of a semitropical character."

It will be seen that the learned and careful observer from whom I have just quoted, does not even hint at the probability of glaciation being produced, in the district which he describes, by the action of the winds in question, although, as will have been remarked in connection with a former extract from the same work, his attention was specially directed to the climate of the South Pacific lands. It will also be noted by those who are acquainted with the indigenous vegetation of the western coast of the South Island, how closely it resembles in character the vegetation of that part of the tract referred to by Mr. Darwin, which lies between the fortieth and forty-fifth parallels, although the drier climate which the former enjoys, owing to well-known causes, enables some of the fruits he mentions to be ripened in a much lower latitude in New Zealand than is possible on the west coast of South America.

I propose, in the sequel, to add some further remarks in connection with this branch of my argument, although I think I have already sufficiently shown that the only "causes" assigned by Dr. Haast for the alleged glaciation, even assuming that he had not committed a grave error in his statement of facts, would be utterly unequal to the occasion. But let us examine into the probability of the occurrence of the alleged glaciation, judging of such probability from a consideration of matters which are not even hinted at by Dr. Haast, although, as will be seen, they must have a very important bearing, not only upon the learned doctor's propositions, but also upon all questions affecting the existing physical conditions of these islands.

In the first place, their total submergence during the tertiary epoch—and I speak of the whole of the islands advisedly, because I cannot conceive for a moment that the South Island could have sunk 13,000 feet below its present summit level without being accompanied in its dip by the North and Stewart Islands—must have been attended with the complete extinction of all the then existing forms of terrestrial life, unless, *par hazard*, some New Zealand antitype of Noah had amply provided for the emergency. But, as if to prevent any beneficial result from such provident foresight, as well as all other reasonable prospect of re-peopling the islands, no sooner do they begin to emerge again after their long plunge, than the doctor proceeds to invest them, for an indefinite period, with an uniform pall of ice and snow extending to the very water's edge!

Having inflicted these terrible blows, he ought certainly to have helped us

to some explanation of the manner in which they ultimately shook off their dreary clothing, and assumed, in lieu thereof, their present rich and varied garb, and how they became inhabited by the moa and the kiwi, and by other creatures whose powers of crossing the 1200 miles of ocean which intervene between New Zealand and the nearest continental land, even if they had originated there, are of the very weakest. Perhaps, indeed, the learned doctor believes that our present fauna was evolved "in those pleistocene times" out of the moral consciousness of some mollusc or crustacean resting and pondering, after the long winter, on the shores of the pleistocene sea; or, perhaps, all this dreadful submergence and glaciation may have been confined to the area of the present Province of Canterbury, as a fitting preparation (in the eyes of Dr. Haast) for the formation of the celebrated Canterbury plains, leaving the rest of New Zealand to pursue the even tenour of ordinary geological ways.

But I will ask Dr. Haast, whether he has at all considered the effects which the grinding action of such an ice sheet as that in which he has chosen to envelope New Zealand "in those pleistocene times" would produce upon its surface? Has he speculated, beyond the conjectured "desolate aspect," upon the appearances which the surface would present when, in the fullness of time, the ice sheet had been removed? Can he, for example, point to the existence, in any part of New Zealand, of boulder clays of the class constituting the upper glacial series, as exhibited in the north of England and in many parts of Scotland, and which Mr. Wood has given good reasons for believing to be composed of matter formed underneath a great ice sheet analogous to that of Greenland, and gradually extruded upon the floor of the sea? So far as I can judge, in no part of the South Island, at all events north of the Waitaki River, can the morainic matter that occupies the great mountain valleys be referred to the action of such an ice sheet. The terminal moraines, even when of largest dimensions, are restricted to these valleys, in some instances no doubt extending to short distances beyond them, but in most cases confined to their upper reaches.

Let us see how Mr. Geikie sums up the work produced by the ice sheet which enveloped the Highlands of Scotland in that part of the "great ice age" during which the Lowlands were submerged. At page 252 of the work already quoted from, he says:—"When the great ice sheet was beginning to deposit the boulder clay which is now met with in the maritime districts, the higher hills of the central Lowlands stood above the level of the mer de glâce, like islands in a frozen ocean. At the same time the mountain ridges of the Highlands and the bold hills of the southern uplands rose up so as to separate the ice sheet into a series of gigantic local glaciers, which, however, still coalesced to form one mighty stream upon the Lowlands. Frost shivered the rocks and loosened out great blocks, which eventually toppled down upon the ice below,

and along with heaps of angular rubbish were slowly carried away. Sometimes the stones and boulders fell into crevasses, or between the ice and the rock of the mountain slopes, and so got ground and polished on one or more sides, but they always travelled farther and farther off from their parent mountains. The tops of the Lowland hills, peering above the ice, caught some of the wanderers as they drifted past, but many were borne out to the terminal front of the ice and dropped into the sea, where they mingled with the scratched stones that were being pushed out from underneath the glaciers. As the ice continued to melt, erratic and angular débris was stranded at ever-decreasing heights upon the mountain slopes and hill sides, and at last the ice drew back from the sea and the glaciers then dropped their rubbish upon the land. Great streams of water escaping from the melting ice swept the morainic matter down the valleys, and angular stones and rubbish, as they were pushed along, became rounded by attrition and arranged by the rivers in great flats of gravel and sand. Thus, ever as the glaciers withdrew, the angular débris that gathered in front of them was ploughed down and distributed over the bottoms of the valleys by the swollen rivers, the perched blocks at great elevation on the sides of the valleys, and upon the slopes of the Lowland hills, still remaining to indicate the heights formerly reached by the glaciers. There being no great river valleys draining from the mountain regions in the low grounds of Lewis and Caithness, the absence of glacial deposits from such districts is easily accounted for. To what extent the ice was eventually reduced we have no means of ascertaining, neither do we know much of the climatal condition which at this period obtained in Scotland. All that we can safely assert is, that the ice disappeared entirely from all the low lands, and drew back into the deeper mountain valleys. Of the plants and animals which at this time may have clothed and peopled the land, we know next to nothing. I have here and there, in the gravel and sand beds, detected some vegetable matter, but in too decomposed a state to enable me to say what it was. In one section, however, near Carhum, on the Tweed, I obtained from a bed of sand in the series numerous remains of water-rats and frogs. It would be hard to believe that these were the sole denizens of the land; as yet, however, they are all we have got to show. After such conditions had lasted for a longer or shorter period, the land gradually sank into the sea. As it slowly went down the waves and currents ploughed up and re-distributed much of the old glacial accumulations and river deposits. Broad terraces of gravel and sand were cut into, and their materials winnowed and re-arranged. Here and there, also, ridges of gravel and cones of sand were heaped up in places where no sand and gravel existed before, the sea using up for the purpose the till and morainic rubbish."

If such an ice sheet as Dr. Haast has conjured up had ever occupied the

surface of the South Island since it attained its present elevation above sea level, or indeed since miocene times, the utter absence of such evidences of its existence as those which occur in Scotland, resulting from similar phenomena, is most unaccountable. But whilst I utterly deny Dr. Haast's propositions, I at once admit that the former existence of glaciers of great extent is a necessary assumption in any attempt to account for the phenomena presented to us in the localities mentioned in my former paper.

I would further ask Dr. Haast, how it is that he has not brought forward any evidence derived from the organic world of "those pleistocene times," in order to establish his propositions? Surely, if the views he has propounded be at all based upon fact, he would have been in a position to go further than the barest assertions in support of them! Do any of the pleistocene deposits which he has examined afford indications of such a climate as that which must have accompanied the alleged glaciated condition of these islands? What can he point to in the features of the existing organic life of these islands, from which we can trace the former existence of such a glaciation?

The careful comparisons which have already been instituted between the existing Mollusca of our seas, and fossil species extending in age from recent up to upper eocene times, has failed to indicate the occurrence of any such glaciation. The number of pleistocene fossils examined was very considerable, and a large proportion of them was obtained in the South Island, in localities in which evidences of such a glaciation would have been found in abundance, if the glaciation itself had ever existed.

Again, how is it, if the alleged glaciation had attained the dimensions assigned to it by Dr. Haast, or indeed anything approaching such dimensions, or even dimensions equal to those of the greater glacier period of the Swiss Alps, that we do not find evidences of its extension at points beyond those to which that extension is limited in the maps appended to his report? If, as he asserts, the area of the Canterbury plains maintained its present position relatively to sea level, and its present surface conditions, throughout the period of the asserted glaciation, the absence of all evidence of the kind mentioned by Morlot and others in proof of the extension of the Swiss glaciers during the greater glacier period of the European Alps, is most remarkable. During this latter period the great valley of Switzerland was filled with ice, as is attested by the presence of unmistakable remains on the Jura, whilst, on the southern side of the Alps, ample evidence exists, in the form of moraines of truly gigantic dimensions, that contemporary glaciers invaded the plains of the Po. "Although these large glaciers had retreated for a time" (I quote from Sir Charles Lyell) "they advanced again, but on a smaller scale, though still vastly exceeding in size the largest Swiss glaciers of our day." Careful observers like Professor Heer, who is cited by Sir Charles Lyell in reference

to the climate of Switzerland, during the interval between these two glacier periods, do not content themselves with bare assertions on points of scientific importance, and the learned Professor took care to point out that the character of the fossil fauna and flora from the drift of the intervening period was such as to support the *a priori* conclusion deducible from a comparison between the greater and the less extensive glaciation, that the climate was milder during that intervening period than that of the periods which had preceded and succeeded it.

But Dr. Haast adduces no evidences of the several kinds I have pointed out in support of his assertions, and simply, as I believe, because they do not exist. No morainic accumulations are to be found on the Canterbury plains, except at very short distances below the mouths of the greater valleys. No boulder clays are to be found of the kind which would result from the action of an ice sheet. Nowhere on Banks Peninsula are to be found the smallest traces of glaciation. Nothing in the character of the pleistocene fauna or flora indicates it. In fact, I may safely challenge Dr. Haast to produce the slightest evidence, calculated to satisfy scientific men, in support of his assertions. Tyndall tells us that "the scientific mind is fond of verification, and never neglects it where it is possible." Dr. Haast prefers broad assumption and bare assertion. I have no hesitation, however, in utterly rejecting his propositions respecting the alleged glaciation, not only because they are rash and unsupported, but also because they conflict with all the facts which are thrust upon us (so to speak) by an examination of the existing physical features of these islands.

I might here have closed this paper, but I have thought it desirable not to do so without referring to some remarks made by Dr. Hector during the short discussion upon my paper of last year, and I do this more especially because those which I am about to make in reply have also a strict bearing upon the general subject under discussion. On that occasion Dr. Hector referred to a letter written by himself to Dr. Hooker, in 1864 (which is quoted approvingly by Sir Charles Lyell, at page 241 of the first volume of the Principles of Geology, tenth edition), in which, if the quotation of Sir Charles be correct, Dr. Hector appears to have stated in effect as follows:—"Dr. Hector has remarked that the north-west winds, when they blow for several days in succession from Australia to the South Island of New Zealand, are so hot and dry as to cause great floods by the sudden melting of the snow on the Northern Alps of that island. He observes that if Australia were submerged, or if at some former period the sea covered a large portion of the space now occupied by that continent, the New Zealand glaciers, which are now of considerable size, would have been more voluminous."

Now, although Dr. Haast has frequently quoted Dr. Hector in a manner

which might lead to the assumption that the latter agreed, in the main, with the glaciation theory already discussed in this paper, it is clear that the language of the letter just cited does not even countenance Dr. Haast's extravagant propositions. But whilst, as already stated, I fully admit a former extension of the glacier system of the South Island mountains, I am unable, partly for the reasons already urged and partly for those to which I am about to refer, to accept the views set forth in Dr. Hector's letter as sufficient to account for it.

In an earlier part of this paper I pointed out that the principal winds which impinge upon the coast of New Zealand are the well-known westerly winds which prevail between the thirtieth and sixtieth parallels of south latitude. Satisfactory reasons are given by physical geographers why these winds should be drier than the corresponding winds of the northern hemisphere, but I think I shall be able to show that, although the climatal condition of the western coast of New Zealand is, in great measure, due to the action of these winds, the winds themselves are in no degree dependent upon the climatal condition of Australia for that in which they arrive on our coasts.

It must be remembered that when these winds become surface currents they are cool winds, the warmth they acquire, and which enables them to pick up moisture, being due partly to condensation and partly to friction, while they become charged with moisture during their passage over the waters by which Australia is separated from New Zealand. In the next place it must be borne in mind, that the distance between these islands and the eastern coast of Australia is not less than 1200 miles; and, lastly, that the whole of the heat producing area of Australia, if I may use such an expression, lies to the north of the thirtieth parallel, and therefore within the south-east trade region. Moreover, all physical geographers class the climate of that part of Australia which lies to the south of the thirtieth parallel as amongst the temperate climates of the globe.

So far, then, from our north-west winds coming to us in a heated condition, in consequence of having passed over Australia, the winds which pass over that part of it which can in any degree be treated as lying to the north-west of us, blow towards a directly opposite quarter. Indeed, it is in great measure owing to this that the island of Timor, the eastern end of Java, and the southern peninsula of Celebes present the parched appearance particularly mentioned by Mr. Wallace in his work on the Malay Archipelago; whilst Mr. Maury and other writers on physical geography explain, that the chief reason why Australia itself is so dry a country is that its eastern coast line is stretched out in the direction of the south-east trade wind, which therefore only fringes its shores with moisture. Dr. Hector appears, when considering the source of

the moisture of our north-west winds, to have overlooked the fact, that the great equatorial current of the South Pacific, after flowing in a broad stream down the eastern coasts of Australia and Tasmania, curves to the northward, in which direction it flows along, but at some distance from the western coast of New Zealand still possessing a temperature of 68° of Fahrenheit. It must not be forgotten, moreover, that the northern point of New Zealand lies within 600 miles of the tropic of Capricorn, and within 300 miles of the southern belt of calms, whilst the climate of the whole (as the following extract from a publication on New Zealand, to which Dr. Hector contributed this portion of its matter, will show) is generally milder than that of corresponding latitudes in Europe :—

"The changes of weather and temperature [in New Zealand] are very sudden ; calms and gales, rain and sunshine, heat and cold often alternating so frequently and suddenly as to defy previous calculation, so that there cannot be said to be any uniformly wet or dry season in the year. But, although these changes are sudden and frequent, they are confined within very narrow limits, the extreme of daily temperature only varying throughout the year by an average of twenty degrees, whilst in Europe (at Rome and at other places of corresponding latitude with New Zealand) the same variation amounts to or exceeds thirty degrees. In respect to temperature, New Zealand may be compared either with England or with Italy, but London is seven degrees colder than the North, and four degrees colder than the South Island of New Zealand, and is less moist.

"The mean annual temperature of the North Island is 57 degrees, and of the South Island 52 degrees, that of London and New York being 51 degrees, whilst at Edinburgh it is only 47 degrees, the heat in summer being tempered by the almost continual breezes, and the winter cold being not nearly so severe as at any of the above mentioned places, except in the uplands and extreme south.

"The mean temperature of the different seasons for the whole colony is, in spring, 55 degrees ; in summer, 63 degrees ; in autumn, 57 degrees ; and in winter, 48 degrees ; January and February, corresponding to July and August in New Zealand, and July and August, corresponding to January and February in England, the two coldest, except in Nelson and Wellington, at which places the mean temperature is lowest in June and July.

"At Taranaki the climate is remarkably equable, as snow never falls near the coast. At Wellington it is very variable, and subject to frequent gusts of wind from the hills which surround the harbour.

"Nelson enjoys a sheltered position and a clear sky. In Canterbury the seasons are more distinctly marked, the frost in winter being occasionally severe (although it never freezes all day near the coast) and the heat in

summer often very great. The winter in Otago is decidedly colder, and severe frosts with deep snow on the uplands are common in the winter.

"Stewart Island is subject to violent winds and frequent fogs.

"Strong winds are prevalent thoughout the colony, and particularly in the straits.

"Rain falls frequently, but seldom in such excessive quantity or for periods of so great length as in Australia, the heaviest rain seldom exceeds two days' duration, excepting on the West Coast, whilst it is rare for a fortnight to elapse without a shower. The rainfall for the year 1871 was 54½ inches, the average rainfall in England being ."

In conclusion, I repeat that, for the reasons shortly given in this paper, I have no hesitation in believing Dr. Haast's glacial hypothesis to be utterly untenable, whilst he has called upon his readers to accept it without adducing in support of it any of those evidences which alone should satisfy the judicious enquirer, and I cannot help expressing my regret that he should continue to maintain those views dogmatically, in opposition to that simpler explanation of the phenomena to be elucidated, which the observance of sound principles of geological investigation might have led him to.

Note.—Since the foregoing paper was written our President has stated, in the address with which he favoured us at the opening of this year's session, that the north-west winds which impinge upon the west coast of the South Island derive their heat from the surface of Australia. This is a repetition of what I considered, for the reasons already shortly stated, to have been an error on the part of Dr. Hector; but, seeing that our President has also given his countenance to the same views, I think it now necessary to state, in somewhat further detail, the reasons which weigh with me in rejecting it.

All physical geographers agree as to the direction of the great air currents which result in the trade winds, and of those by which the place of that portion of the atmosphere which is engaged in the production of these winds is refilled. In the southern hemisphere the current which ultimately produces the south-east trade wind is an upper current flowing towards the north-west, in a sort of spiral or loxodromic curve, between the sixtieth and thirty-third parallels of south latitude. On reaching the latter, at the outer edge of what are termed the calms of Capricorn, it plunges, passing under the comparatively warmer currents (to which I will hereafter refer) and becoming a surface wind, blowing more directly towards the north-west until it reaches the equatorial belt of calms. After it has thus become a surface wind it is called the south-east trade wind. In like manner, the current which produces the north-east trade wind flows in a similar spiral or loxodromic curve, as an upper current, between the parallels of 60° and 30° of north latitude, at the latter of which it also plunges, passing through the warmer current to which I will shortly refer,

and becoming the north-east trade wind, blowing towards the south-west until it also reaches the equatorial belt of calms. This belt of calms is caused by the contact of these two currents. At this point both begin to ascend, and, becoming cooler by expansion in the upper region, a considerable proportion of the moisture which they have absorbed as trade winds is precipitated. According to Maury, each of these upward currents, after passing over the tropical region between the equatorial and solstitial belts of calms, again plunges at the latter, passing under the descending cold currents from the polar regions. Whilst thus plunging a further proportion of the moisture left in them is condensed, causing that peculiar cloudy character which distinguishes the districts between the limits of the solstitial calm belts. After this plunge they again become surface currents, flowing towards the poles in spiral or loxodromic curves, in order to replace the material of the upper polar currents above referred to, but in directly opposite directions, the north-east trade wind becoming a north-west wind to the south of the thirty-third parallel of south latitude, and the south-east trade becoming a south-west wind to the northward of the thirtieth parallel of north latitude. Those two return currents are then called the anti-trades.

Sir John Herschell, who differs in some respects from Maury, says:—"The trade winds occupy two belts on the earth's surface, on either side of the equator, which are limited on the equatorial side by a belt of calm air, the movement of which is upwards, and in which no prevailing tendency east or west is perceivable. On the polar they are limited by two belts of comparative calm, with uncertain and variable winds, which for our present purpose we may consider as nearly coincident with the tropics. Over the belt of equatorial calms, the north-east and south-east trades, *reduced to meridional directions by the eastward frictional impulse of the earth's rotation* (Basil Hall, Fragments of Voyages and Travels, 2nd series, 162) meet, and, to a certain small extent perhaps, commingle in their upward movement, which, however, can only be the case with those portions of air which actually attain the medial line or approach very near it; for, as the regions of calm extend to four or five degrees on either side of that line, the greater part by far of either indraught will rise on its own side, and must of necessity be turned over towards the pole of its own denomination, and return as an upper current by a track precisely the reverse of that of its arrival. On the other hand, over the region of tropical calms a portion of the descending air of the upper current, where it first strikes the earth, is dragged back into the tropical circulation, while the rest goes forward to form the anti-trades (or south-west and north-west winds) of the temperate and polar zones, which, as prevalent winds, with more or less frequent interruptions according to local circumstances, occupy both the extra-tropical regions."

It will be observed, however, that although Sir John Herschell considers his own as the correct dynamical view of the course of the great air currents after their meeting at the equatorial belt of calms, he does not differ from Maury as to the general effects resulting from their meeting. It may be presumptuous in me to attempt to decide between two such authorities, but the climatal condition of the northern part of Australia induces me rather to lean to the views of Mr. Maury. Now, looking to the geographical position of Australia, the cause of its peculiarly dry climate will at once be seen, for its eastern coast, to the northward of the thirtieth parallel, is stretched out in the direction of the south-east trade wind, which only fringes its shores with moisture, whilst the whole of the continent to the north of the thirty-third parallel receives the dry upper polar current in the form of the south-east trade wind. To the south of that parallel the winds are the return, or anti-trades, deprived of a large proportion of the moisture they had absorbed in their passage over those parts of the waters of the North Pacific which lie to the windward of Australia, and restored to a comparatively warm condition by condensation. But they still retain a sufficient portion of moisture, increased moreover in their passage across Bass Strait, to make the climate of Tasmania temperate and agreeable.

Looking, further, at the geographical position of New Zealand in relation to Australia, and bearing in mind that the return current from the north-east trades, which forms the north-westerly winds of the southern part of our hemisphere, moves in the curves before indicated, it is impossible that any portion of the north-west winds which blow over the southern parts of Australia should reach New Zealand at all; I have little doubt, indeed, that they pass considerably to the southward of these islands, and that their most easterly margin would not be found further north than the Auckland Islands. Nor is it at all essential to invoke the heated condition of the surface of Australia to account for the warmth of the winds of the Canterbury plains. The degree of warmth is very much the same as, but perhaps a little greater than, that of the north-west winds of the southern parts of Australia, and becomes sensible in the manner explained by our President.

I quite agree with our President as to the chilling effect upon the person of these winds as they come off the sea, but it must be remembered nevertheless that, as anti-trades, they are considered to be warm winds by physical geographers (see Sir John Herschell's Physical Geography, page 268). I believe, moreover, that the winds in question, before they reach the plains, receive a large amount of additional heat from radiation, for these hot north-west winds are usually preceded by dry, cloudless, and calm weather on the eastern side of the mountains, and I know from experience how extremely sultry the air in the valleys becomes during such weather. It is, of course,

difficult to convey a clear idea of these views without the aid of diagrams, but an examination of the wind and ocean current charts of the southern hemisphere will, I think, show that they are consistent with received opinions. Our President also leads us to believe that he inclines to Dr. Haast's views as to the glaciation of these Islands in pleistocene times, which, however, he refers to cosmical causes in no degree hinted at by Dr. Haast in the paper I have criticised, and at the same time appears indisposed to acquiesce in the assumption of a greater elevation of these islands during pliocene times. But it appears to me that our learned President, in dealing with the latter question, has entirely overlooked the evidence afforded by the organic life of the group of islands curving round the eastern side of New Zealand, from Sunday Island in the north, by the Chatham group to the Antipodes, the specific identity of which with that of New Zealand, can, as I conceive, only be accounted for by assuming a former land connection between them, severed by a subsidence which took place since miocene times.

Art. LXIX.—*On the Date of the Glacial Period; a Comparison of Views represented in Papers published in the Transactions of the N.Z. Institute, Vols. V. and VI.* By A. Dudley Dobson, C.E.

[*Read before the Nelson Association, 5th April,* 1875.]

The last issued volume of the Transactions of the New Zealand Institute contains several papers on the Glacial Period of New Zealand, which are exceedingly interesting, not only from the descriptions given of geological and geographical phenomena, but also from the different conclusions arrived at by the several writers. I have ventured to think it would be interesting to others as well as myself to see the different views placed side by side, with the object of ascertaining in what they agree, and in what differ; and although Dr. Hector, in his annual address to the Wellington Philosophical Society, very truly remarks, "that much has still to be done before any decision on this point (date of glacial period) can be arrived at," I am of opinion that an examination of the various arguments as at present advanced will greatly assist in clearing the way, and may, perhaps, put observers upon their guard against fallacious theories. But very few observers are capable of simply recording observations without having some theory on which to adjust them; it therefore becomes the more necessary to examine carefully into every hypothesis, and reject all which are palpably untenable, holding temporarily to the one which seems to explain best the records of bygone times which everywhere surround us.

In volume V. of the Transactions we find an interesting paper on the Date

of the last great Glacial Period of New Zealand, by Captain Hutton, without which the consideration of this subject would be incomplete. The author's views, briefly summarised, are as follows:—That the greatest extension of the glaciers was coincident with the greatest elevation of the land, and occurred in older pliocene times, which was a period of elevation; the newer pliocene period was one of subsidence; followed by elevation in pleistocene times, and that elevation is still going on.

In volume VI., Mr. W. T. L. Travers, in a paper on the Extinct Glaciers of the Middle (South) Island of New Zealand, infers that the extension of glaciers was due to a great elevation of the land in miocene times, which elevation continued into and was greatest during pliocene times, when subsidence commenced and continued into pleistocene times, during which a fresh upheaval took place; and that in consequence of the elevation of the land, and a much larger area being above water, New Zealand assumed a quasi-continental character.

Mr. J. T. Thomson, F.R.G.S., (Glacial Action in Otago) considers the island must have been at a considerably lower level than at present, the land covered with glaciers, and surrounded by a wintry ocean, the country generally presenting similar features to Victoria Land in the Antarctic Ocean. The author, so far as I can learn, does not touch upon the question of geological age.

In a paper written by myself (Notes on the Glacial Period), the greatest extension of the glaciers was considered to be due to elevation, which commenced towards the close of the pliocene period and continued, the greatest elevation of the land being marked by the greatest glacial extension; subsidence then took place, continued up to the present time, and is still continuing.

So far I have briefly given the views advanced by the writers of the papers before mentioned; but, in addition to the papers, we have the remarks made by Doctors Hector and Haast in the annual addresses published in the Proceedings, which will well repay perusal, and to which I shall allude subsequently, merely premising that, from what I have read of the writings of these gentlemen, if I understand them aright, they neither consider much elevation of the land to have been a necessary accompaniment to the glacial period, referring the change more to other causes—the wearing away of mountains, etc., and possibly to changes in the relative proportion of land and water in the neighbourhood of New Zealand.

Messrs. Hutton, Travers, and myself are agreed in supposing a great elevation of land to have been the primary cause of the extension of the glaciers, and subsequent depression the cause of the extension, but differ materially as to the date of the elevation and subsidence respectively; Captain Hutton considering the old pliocene period one of elevation, the newer pliocene one of subsidence, followed by elevation, which he supposes to be at present

going on. Mr. Travers agrees in the main with Captain Hutton, only supposes the elevation to commence during the miocene period, and continue into pliocene times, subsidence and fresh upheavals occurring during pleistocene; whilst I have considered both the elevation and subsidence to have occurred in postpliocene times, and that no general elevation has occurred since.

Before the former of these theories (Hutton's) can be accepted as tenable, it is necessary to show that the newer pliocene is partly contemporary with, and partly subsequent to, the glacial period, and in this case, as the glaciers disappeared during the pliocene period, it would be impossible to find any pleistocene strata covered by morainic matter. Captain Hutton regards the Moutere Hill drifts, which cover so large a portion of the north central portion of the Nelson Province, as older than the glaciers, in which case they must be either miocene or older pliocene, but could not possibly be of later origin. If I am not mistaken, the Moutere Hills are composed of the same drift (*i.e.*, are of the same age) as the drift which covers all the lower country from the shores of Blind Bay on the north to the Mikonui Hills on the south—it varies in character, being generally composed of the same materials as the nearest adjoining mountains—for the most part it lies nearly horizontal, but in the Grey Valley and to the southward appears to have been slightly disturbed, dipping somewhat to the northward and eastward. The general structure is much about the same throughout—drift shingle alternating with beds of sand, the shingle in places forming a tough conglomerate with the stones more or less decomposed; in others the shingle hard and loose, and washed down the gullies by every rain. Dr. Haast thus describes a section he obtained in the Grey Valley :—

"Near the junction of the Mawheraiti with the Grey, on the southern side of the main river, I obtained another section. Here the banks are almost vertical, exposing a section of nearly 120 feet. In the river itself we find a large stratum of clay marl, in which are also many pieces of drift wood converted into lignite. These beds, of a bluish colour, are nearly horizontal, and at one place the stump of a tree, fifteen inches in diameter, broken off above the root, stands apparently in sitû, the roots still adhering strongly to the clay marl, so as to lead to the impression that it grew upon the spot. These beds, which rise nine feet above the level of the river, were probably deposited in a shallow estuary; they are divided at unequal intervals by horizontally deposited layers of mica; they change insensibly into loam, which is succeeded by a large accumulation of sand, gravel, and loam, interstratified with layers of boulders, partly angular and partly rounded, and resembling very much the drift formation near Nelson."*

* Report on a Topographical and Geological Exploration of the Western Districts of the Nelson Province, N.Z., by Dr. Haast, p. 103.

Dr. Haast makes no mention of finding fossils in these strata, but suggests the age as "younger tertiary (pliocene?)." In going up the Ahaura River excellent sections of these beds are obtained at the Big Gully, ten miles from Ahaura township. The river has cut down through 400 feet, and there is no sign of it having yet reached the bottom of the series. Going further up the river the strata dip more to the eastward. Just before reaching Starvation Point the stones get much larger, having much the appearance of an ancient river bed, then suddenly the drift changes to loose sand, covered with morainic matter—loose angular blocks many tons in weight lie scattered over the surface.

These drifts, both in the Grey Valley and the Upper Buller, rise nearly 2000 feet above the sea level. It is in the rewashes of this drift that the principal alluvial workings in the Grey Valley occur.

In the Upper Buller, near Lake Rotoiti, the drift is for the most part very loose, but proceeding to the northward it becomes more clayey, the stones being much decomposed, forming a softish conglomerate, with intercalated beds of clay and sandstone containing streaks of lignite. Although I have taken every opportunity of searching for fossils in these beds, I have never yet succeeded in finding any, nor have I ever heard of any being found. Judging from position and general appearance, I consider the drifts must be much younger than the Nelson tertiaries at the Port Hills and Jenkins' coal mine; and, without very strong evidence to the contrary, I see no reason for assigning to them the great age that would be necessary, adopting the hypothesis of either Captain Hutton or Mr. Travers; for whether we consider the glacial period to have been in older pliocene, or to have begun in miocene, times, the drift being older than the glaciers must be at least miocene. I have discussed this question at some length, as I believe the careful examination of the drift formations of New Zealand generally will throw a great deal of light upon many points at present unsettled, and that until the age of the drift is satisfactorily settled we may speculate in vain upon the age of the glacial period.

The next question that claims attention is the general question of elevation and subsequent depression, which, apart from the question of age, is common to the hypotheses of Captain Hutton, Mr. Travers, and myself. A glacial epoch is, no doubt, easily accounted for, by supposing an elevation of land into the snow line, and the gradual extinction of the glaciers must necessarily follow a subsidence; but before this can be accepted as anything more than a provisional hypothesis much more proof is required than has been put forward as yet. I am inclined to consider the great drift to have been partially caused by marine action, but have no evidence to bring forward in support of my views, further than the similarity of the drift and gold in many of the inland

leads, now lying at high levels, to the drift and gold of the leads lying along the coast above the present level of the sea, which so exactly resemble the beach leads at present forming that I cannot doubt but they have been formed in a similar manner.

I may here mention that an elevation theory is not by any means generally accepted as the chief cause of glacial extension. Dr. Haast, who has studied glacial phenomena more than any other geologist in New Zealand, from what I can learn from his writings, does not appear to consider former glaciation due to greater elevation; and Dr. Hector, in his address published in the sixth volume of the Transactions, suggests a larger area of ground both above high water mark and above the snow line, and alterations in the surroundings of New Zealand.*

Recent upheaval is the last phase to be considered, and in this I do not agree with either Captain Hutton or Mr. Travers; and I cannot see that any evidence in favour of recent elevation is given by either of the above named gentlemen; had any recent elevation taken place anywhere round the shores of Blind Bay, traces should certainly be existing at present. I am well acquainted with the north and west coast of the Nelson Province, and the east and west coast of the Canterbury Province, but know of no raised beaches which I should consider of late date. It is true, I conceive the auriferous drifts which are worked for gold on the coast, at levels varying from fifty to 400 feet above sea level, owe their shape to the combined action of sea and river currents; but I believe these leads or beaches to have been deposited prior to the glacial period, as in several places they are covered with moraine matter.

The Canterbury plains show no signs of raised beaches, and Dr. Haast's report upon the formation proves beyond all doubt their fluviatile origin. In a paper on the Glacial Period, published in the last volume of the Transactions of the New Zealand Institute, I stated that the drift formation of the Canterbury plains began during the pliocene period, when I considered the greater part of the lower lands of the South Island were submerged beneath the sea. This statement requires qualification; if I am correct in imagining a great submergence to have taken place previously to the glacial epoch, marine deposits and gravel drift would undoubtedly have been formed, but the enormous amount of detritus brought down by the rivers during the glacial period would be sufficient to entirely bury all evidence of marine action throughout the area now occupied by the Canterbury plains. This want of evidence of marine action is the greatest difficulty to my mind in the way of the elevation theory, without we assume the elevation to have been chiefly confined to the western side of the island, which rose and fell without affecting the general level of the east coast.

* Trans. and Proc. N.Z. Inst., VI., pp. 374 and 385.

This is not unreasonable, for without proof I see no reason why we should imagine elevation or subsidence to occur horizontally over any large area; movement confined chiefly to the west side of the island would account for several apparently irreconcilable difficulties. It must be understood that I mean movement greatest near the west coast, and lessening eastward, becoming nothing at the east coast; it would fully account for raised beaches on the west coast, and none on the east. As there is some doubt as to whether the auriferous leads on the coast are raised beaches, a short description will not be out of place here. From Hokitika on the south to Karamea on the north, drift deposits occur, which are all more or less auriferous. These deposits are composed of gravel and sand; the gravel being granite, indurated sandstone, quartz, and hard schistose rocks, all well water-worn, and having the circular disk-like form always met with in beach shingle.

Confining description to the Nelson Province, a lead of this description occurs at Point Elizabeth, four miles north of the river Grey; it is about fifty feet above the present sea level, and was most probably deposited by the combined action of the sea and river on what was then a beach at the mouth of the Grey, the river Grey having once had its outlet to the northward of Point Elizabeth, before it broke through the limestone range and formed its present channel. The drift either lodged only in this spot, or, if there was a greater extension, all trace has been washed away, for the deposit which proved so very rich in the early days of the Grey diggings extended for a distance not exceeding thirty chains in length, nearly parallel to the existing beach, and not more than one or two chains in width.

Proceeding northwards, patches of gravel occur at a height of about sixty feet above sea level at various places along the hill sides, but none have yielded much gold, until we arrive at Brighton, where the drift extends over a considerable area of country. The gold leads in this district exactly resemble beaches, and are parallel to the present water line.

From Brighton northward to the Waimangaroa the drift extends, bearing numerous gold leads, the highest being at Dawson's Terrace, about 400 feet above the present sea level. Near Charleston leads were worked on six different levels, all of which bore the same littoral character. North of the Buller the leads rest on a bottom of fine sandstone, are overlaid by a drift of heavy granite boulders, which is in its turn capped by a mass of large sandstone blocks, which I believe have been brought down from Mount Rochfort by glacial action.

It is impossible to give an adequate description of these gold leads in a few words, or to convey any useful information unless accompanied by plan and section, but I hope at some future time to be able to write a description accompanied by such plans and sections that will have some value apart from any hypothesis as to their date and origin.

Southward of Hokitika enormous glaciers covered the face of the country, leaving mountains of moraine matter to indicate their former dimensions; lateral moraines run from the foot of the mountains to the sea, but nowhere could I observe any trace of marine action posterior to the glacial times.

In a report on the West Coast Gold Fields, made by Dr. Haast for the Canterbury Government in 1865, after a careful examination of the country and the gold workings, the auriferous drift covering the face of the country from the Grey to the Mikonui—and which is no doubt of the same age as that occurring throughout the Grey Valley—is attributed to the pliocene period. Throughout the report he speaks of the loose nature of this drift, and attributes its preservation to favourable circumstances, it having been destroyed in many places by glacial action. He describes the drift overlaid by moraine matter at Kanieri, near Hokitika, and in all cases, so far as I can learn, he makes no mention of any recent raised beaches, or any trace of marine action on the great moraines—matters which could scarcely have escaped his observation.

I think, from the consideration of the foregoing, it may be safely assumed that no general elevation has occurred since the glacial period, and that if subsidence was the cause of the extinction of the glaciers, subsidence may be considered as the latest movement. The age of the youngest member of the "great gold drift" series, to meet the hypothesis of Messrs. Hutton and Travers, must not be later than miocene, and, as I have previously remarked, there is no evidence advanced to support the belief in such an age.

The elevation and subsequent subsidence hypothesis, as accounting for the former great extension and after extinction of the glaciers, may be considered a good provisional one, as readily accounting for a great variety of phenomena. But, having already given my own views, I need not repeat them, and shall now leave the subject, trusting that I have discussed the matter clearly, and have given fairly the views of the authors of the papers under discussion.

Before concluding, I may remark that the evidences of glacial action so widely distributed over the South Island of New Zealand, and occurring on so grand a scale as to attract attention even from the most uncultivated observer, form one of the most interesting of the geological records which the lovers of science are called upon to decipher.

ART. LXX.—*The Glacial Period of New Zealand.*

By THOMAS MACKAY, C.E.

[*Read before the Nelson Association, 5th April,* 1875.]

TO THOSE who in their wanderings throughout New Zealand look with a geological eye at the many evidences they meet with of a glacial period, it is obvious that the moraines and drift formations—many of which form our minor watersheds—have been the result of the same action as that to which similar physical features in tropical climates are due, namely, the breaking up of vast bodies of long accumulated ice, with its stored up forces, in the high altitudes of their great mountain systems. There was doubtless a period in which the region of which this now insular country formed a part experienced greater extremes of temperature, while at the same time the mountain ranges were of a higher elevation than now.

The time, however, of this, or of the changes of eccentricity in the earth's orbit that occasioned the geological revolution, or whatever it may be termed, which supervened, is still to be discovered. By the forces exerted in the latter catastrophe the vast masses of rocks and diluvium were transported to the sites of, and piled up into, the moraines and drifts we now see around us. Assuming, therefore, the present hypothesis to be correct, if ever the periods of alternation of cold and heat in geological times can be measured, an approximate test of the time which has elapsed between geological epochs may be determined, but to do this a reconcilement between cosmical time and geological time must with some certainty first be established. Whenever such a complex problem is solved, a basis of calculation may then be formed by which to measure the distance of time at which our glacial periods happened. For the present, palæontological research is the best key, and when the critical tabulation of the large collections of New Zealand fossils has been completed by Dr. Hector, it will afford a surer criterion than formerly by which to test the several speculations that are current respecting the geological characteristics of New Zealand, and to establish more correct theories regarding them, particularly of recent formations.

While geologists are not yet able to mark the point of union between historical and geological time, nor competent to define when geological epochs terminate and the historical era begins, still, by the aid of palæontological researches and collections, comparisons can be instituted, and indirect inferences formed of the mineral and physical relations of geology proper with the conditions of existence which plants, animals, and the human race bore to each other in prehistoric ages.

Art. LXXI.—*Did the great Cook Strait River flow to the North-West or to the South-East?* By J. C. Crawford, F.G.S.

[*Read before the Wellington Philosophical Society, 25th July,* 1874.]

Last year I endeavoured to show, and I think with some success, that Port Nicholson had formerly been a fresh-water lake.* The theory was founded more on what necessarily must have been the case, supposing the land formerly to have stood at a higher level, than on actual observation of fresh-water deposits. Possibly these may lie hidden beneath the waters of the harbour, but remains of terrestrial vegetation are found in wells within the precincts of Wellington city much below the present sea level, and have probably been originally deposited in the waters of a lake, and, as observations are extended, I have little doubt that additional evidence will be forthcoming in future.

I now propose to continue the reasoning on which this theory was founded, to show that a large river must formerly have run through what is now Cook Strait, and consider in which direction it is most probable this river flowed.

If we consider the somewhat analogous position of the Straits of Dover, we find similar geological formations on the opposite sides of that channel, thus showing that at one time the two sides were continuous. It has been the habit to refer the separation of England from the Continent to some great convulsion of nature, but these violent catastrophes are rather out of fashion at present, and the modern view is that the present line of strait was first denuded and weakened by a large river which ran through the course of the present strait, and of which, probably, the Thames and the Rhine were tributaries, or possibly this river may have been a tributary to the Rhine.

Now, on the opposite shores of Cook Strait we find the geological strata in the position to infer that formerly there was continuity, and that the islands were joined above water. Probably there may have been greater elevation or depression on one side than on the other, and it is reasonable to suppose that when we get into the volcanic zone of Mount Egmont we find an area of former depression. Nevertheless, we may suppose it to be a certainty that the islands were formerly joined together above the sea level.

Are we then forced to seek for a great catastrophe to cause the separation of the islands, or would it not be much more reasonable to follow the analogy of the Straits of Dover, and suppose that a large river first denuded and weakened the channel, by forming a valley, which permitted the sea afterwards to complete the work thus begun?

I think we have sufficient evidence of the powerful work of fresh water

* Trans. N.Z. Inst., VI., Art. XLVIII.

when the land stood at a higher level. We find the series of sounds and inlets on the south side of the strait, Queen Charlotte Sound, Pelorus Sound,* etc., with a depth of from ten to thirty fathoms. These sounds must have been originally excavated by fresh water, and what are now arms of the sea must have been river valleys. A rise in the level of 200 feet would again convert them into valleys.

The deepest sounding in Cook Strait that I can find on the chart is 178 fathoms. Therefore a rise in the land of 1100 feet would shut out the sea, and lay the strait dry. Let us consider what the effect of this would be, supposing the rise to be uniform over the whole plateau. The highest point of the newly-reclaimed land would be between Cape Farewell and Taranaki, where the soundings vary from thirty-three to fifty fathoms. The run of water would therefore be from there towards the south-east, reaching the present sixty fathoms off D'Urville Island, and eighty-four fathoms off Kapiti. In the narrow part of the strait the depth is greater than on either side. This may be caused either by a convulsion of nature, or, by what is just as probable, the scour of the narrow channel being deposited outside, probably to the eastward. In the narrows there appears to be an irregular bottom from 100 to 178 fathoms, while between Cape Campbell and Cape Palliser there is a depth of ninety-nine fathoms. It is clear that, on the before named supposition, the great Cook Strait River must have run to the eastward. If we consider the extent of its tributaries, we must suppose a very large river.

Say on the north we commence with the Patea river. We have next the Waitotara, the Whanganui, the Wangaehu, the Turakina, the Rangitikei, the Manawatu, the Otaki, the Hutt, the Ruamahunga. On the south we should have all the streams flowing from Massacre Bay, Tasman Gulf, the sounds of Pelorus and Queen Charlotte, and the Wairau river.

Suppose we carry the argument still further, and imagine a general rise of the New Zealand plateau to the point of emergence, so that we should join on the Chatham and Campbell Islands. What rise might be required I do not know, for I am not aware that soundings have been taken. In that case we may imagine our great river flowing to the eastward to be joined by the Canterbury and Marlborough rivers, from the Waitaki to the Clarence, probably all converging into one.

The two systems combined would form a river worthy of a large continent.

I would suggest that there are other means of causing a rise or fall of the sea level than the movement up or down of the solid.

At the time when a large part of Europe emerged from the ocean, a corresponding quantity of water must have been displaced. It is by no means

* Pelorus Sound is called a river. It has more of the characteristics of a sound, and is difficult to classify, being neither properly river, nor sound, nor frith.

unreasonable to suppose that this may have passed to the southern hemisphere, and drowned out some of the southern lands. It is conceivable that at one time in the southern hemisphere there was breadth of land from east to west, as well as length from north to south, while in the northern hemisphere, at the same period, the conditions may have been reversed. Possibly this theory may give a clue to the date at which the great Cook Strait River existed.

But, apart from such a speculation, let us consider the effect of local causes. The west coast of the North Island, broken through by the lavas of Mount Egmont and other volcanos, has evidently been an area of depression. This involves the converse proposition, viz., that at one time it was an area of elevation, and we may suppose that the elevation extended across the strait and joined the two islands.

We may suppose that before the deposition of the tertiary rocks there was a period of elevation of the older rocks, followed by periods of depression, during which the tertiaries were deposited. This was probably succeeded by a period of elevation, during which the tertiaries emerged to a greater extent than at present; followed again by a period of depression during the time when the volcanos of Mount Egmont and Ruapehu were in a state of activity.

It may be fair to infer that it was during the latter period of elevation that the Cook Strait River existed. We may picture to ourselves at that period a similar condition to that of the rivers of Canterbury—an upper valley system within the present limits of the strait, the emergence of the river from a gorge in the narrows between Wellington Head (Tory Channel) and Terawiti, and a further course through the plains to the eastward. Whether these plains extended beyond the present sixty or seventy fathom plateau, or were continued for a long way to the eastward, is a point for future research. It is possible that the investigations of H.M.S. Challenger may tend to throw the amount of light on the subject which may be gathered from a study of soundings and of the configuration of the sea bottom.

The arguments for the former existence of a Cook Strait River may be concisely recapitulated as follows:—

1. The appearance of the land in the neighbourhood of Wellington, and its peculiar denudation, lead to the inference that it was formerly the summit of a mountain range of considerable elevation.

2. It is to be inferred that formerly the structural axis of the country lay to the westward, because the volcanic district of Taranaki may be considered to be an area of depression, and, as a converse proposition, formerly an area of elevation, because the sounds of Queen Charlotte, Pelorus, etc., must have been formerly excavated by running water, whereas now they show deep soundings; and because the trend of fall of the bottom of Cook Strait, although

slight, is from the westward to the eastward. It is hardly possible that this could be the case had not the land to the westward formerly stood higher than that to the eastward. Therefore, although the land in the vicinity of Wellington was much higher than at present, that to the westward was higher still.

Having thus, I trust, proved the existence of a former Cook Strait River, I am tempted, in tracing the outlet of the fresh-water lake of Port Nicholson —to which we may perhaps give the Maori name of the harbour, viz., Whanganuiatera—to picture the magnificent fall over which the waters of the outlet rushed before joining the main river. This fall was probably at no great distance from Lyall Bay, although, as the trend of the outlet may have been to the eastward until perhaps it was joined by the Ruamahunga, besides smaller streams, and taking a more gradual slope to its final goal it may have avoided violent action, the question of the waterfall may be considered speculative and involved in some doubt, as although the fall to the main river must have been considerable, it may have been sloped off in a series of rapids by the course of the river trending to the eastward.

We have in this province, and at the present day, an illustration of the possible opening of a strait by the action of a river. The Manawatu, rising in the Forty-Mile Bush, on the eastern side of the main range, breaks through that range at the Gorge, and has cut for itself a channel which does not now stand at much above 400 feet from high-water mark. Consequently a depression of the district to the extent of 500 feet would enable the waters of the ocean to pass through the Gorge into the Forty-Mile Bush, and a little more depression would bring these waters into the valleys of the Wairarapa and Whareama, thus forming a channel with two branches, and converting the peninsula of Wellington Province into two islands. I suppose the water would, at the same time, pass northward through the Ruataniwha plains to Napier, and insulate the southern part of the Province of Hawke Bay.

It appears to me, also, that the present configuration of the sea bottom would probably involve the former existence of a large lake or lakes in that part of Cook Strait lying to the westward, through which lakes the great river flowed. I think I have shown that there was every reason to suppose that formerly a great river flowed through Cook Strait, and that its course was towards the east.

Some further Proofs as to the ancient Cook Strait River, and the Harbour of Wellington as a Fresh-water Lake; also, a Consideration of the Date at which the Islands were united.

[*Read before the Wellington Philosophical Society, 10th February,* 1875.]

On reading my papers on the above subjects at the meetings of the Wellington Philosophical Society during the last two years, I was asked for my

proofs in the way of fresh-water shells, or other evidence, to show the presence of fresh water. Now, if the movement of the land had been upwards instead of downwards, had the harbour or the strait been laid dry instead of being covered with the waters of the sea, no doubt, supposing the theory to be correct, plenty of evidence would have been forthcoming. But, as the movement has been in a downward direction, it is sufficiently obvious that the evidence required is difficult, perhaps impossible, to be found, and that although we have such evidence as the remains of terrestrial plants far below the present surface, yet, to prove the point satisfactorily, we must apply circumstantial evidence and other processes of reasoning.

I think it must be admitted by any one who gives the subject a very small consideration that the two chief islands of New Zealand were at one time united. The flora of both islands is almost identical, the differences mainly consisting in what might reasonably be expected from difference of latitude, and consequently of temperature—absence of frost in the north, and its presence in the south. Thus the magnificent kauri tree and the valuable puriri are not found to the southward of Taranaki, but the tree-ferns and the nikau palm thrive from one end of the islands to the other, along with the mass of forest trees and plants common to both islands. From the evidence of the flora of the islands we may make sure that they were at one time connected.

But the evidence is far stronger when we consider the fauna of New Zealand. From north to south we have the wingless or non-flying birds, the kiwi and the weka. We have the remains of the moa, and other birds wanting in flight, in great quantities in both islands. It is simply out of the question to suppose that these birds spread from the North Cape to Foveaux Strait in any other manner than by land, and for this purpose it will be necessary that we admit the islands to have been joined.

Now, the only way in which the islands could have been united must have been by a former higher level of the land in Cook Strait. This being granted the rest of the argument is incontrovertible. Suppose the bottom of Cook Strait to rise so as to unite the islands, then a river is at once required for the drainage of the reclaimed land, and the required rise would convert Wellington harbour into a lake. There is no alternative.

That the supposed river ran from the westward to the eastward there is every reason to suppose, because the slope of the bottom of the strait is in that direction, and because the ranges between Terawiti and Queen Charlotte Sound have been breached and a wide channel formed.

The argument now leads further, and points to the time at which the islands were joined. This must have been during the period of the existence of the moa and other non-flying birds, and therefore, geologically speaking, at

no distant date. The moa must have wandered on the banks of the great Cook Strait River, and the *Apteryx* and weka have hid in the forest which covered the neighbouring plains.

The previous existence of the moa in both islands is conclusive evidence of the former continuity of the land, and that being proved it follows, as a matter of course, that there was a Cook Strait River, and that Port Nicholson was a fresh-water lake.

ART. LXXII.—*On the Wanganui Tertiaries.* By C. W. PURNELL.

[*Read before the Wellington Philosophical Society, 8th August,* 1874.]

THE Wanganui tertiary beds, or the "Wanganui Formation," as they are called, have already been described by Mr. Buchanan and other competent observers, and there being, so far as I am aware, no great geological problem dependent upon their further examination, another paper on the subject may by some be deemed superfluous. Original observations of physical phenomena always possess, however, a certain value, and as I have lately been enabled to make a personal survey of the tertiaries in the neighbourhood of the town of Wanganui, I determined to put the results of my observations on record.

The characteristic stratum of the Wanganui formation is the blue clay, the development of which is best seen at Shakespeare Cliff, opposite the town of Wanganui, where a thickness of forty feet is displayed. It is composed of a fine greyish blue mud, shown by the fossils which it contains to have been deposited in water of a moderate depth, and probably at the mouth of a river or the outlet of a lake. It is important to notice that it was deposited in a tranquil sea, and which must have remained quiescent for a considerable period to allow of the rich accumulation of fossil shells of which the clay forms the storehouse. A fine oyster bed is conspicuous in the lower part of the stratum, and from top to bottom *Ostrea*, *Pecten*, *Turritella*, *Murex*, *Terebratella*, *Ancillaria*, and many other sea shells abound, all being inhabitants of a coast lying between low-water mark and a depth of 100 fathoms. Sharks' teeth and a species of *Bryozoa* are scattered here and there. The oyster bed is, however, so marked a feature of the stratum, while, moreover, beds of oysters and *Pectens* exist in other strata of the same age in the district, that it would be appropriate to call the blue clay and all the strata above it the "Wanganui Oyster Beds," which name would be more descriptive than the somewhat unmeaning term "Wanganui Formation." Shakespeare Cliff has been so thoroughly ransacked by collectors that its fossils are well known, and the only new shell I can offer is a species of *Waldheimia* which does not appear in the Catalogue of the Tertiary Mollusca, issued by the Geological Department, among the fossils of the Wanganui formation.

The blue clay rests upon a layer of pumice, which seems hardly to have been noticed by previous observers, but which is quite as worthy of attention as the blue clay itself. At Shakespeare Cliff the pumice bed is very thin indeed, but it extends along the bank of the river from the mouth for several miles up, varying from three to fifteen feet in thickness, and underlies the town. It becomes conspicuous on the east bank, a short distance north of Shakespeare Cliff, running parallel with the outcrop on the west bank, and gradually swells in thickness until, between three and four miles from the town, it becomes a component part of a cliff 100 feet high, and is filled with fossil shells. The section here discloses a layer of red volcanic mud, stratified, upon which lies from fifteen to twenty feet of pumice, reduced to lapilli, and forming a tuff, with coarse sand of nearly pure quartz, and an abundance of recent fossil shells of apparently the same age as those in Shakespeare Cliff, but quite different in character. *Turritella* and *Pecten*, so plentiful in the latter place, seem entirely absent, while *Ostrea* is scarce. *Dosinia* and *Venus* are prevalent, as on the modern sea beaches of the neighbourhood, with *Buccinum*, and large species of *Fusus* and *Voluta*. A fine *Crepidula* and a small *Solarium* are characteristic. These fossils are very fragile, crumbling to pieces in the hand, just as if they had been burnt in a kiln. Upon the pumice is superimposed sixty feet, or thereabouts, of mixed volcanic mud and lapilli, which, being weather-worn, presents a curious appearance.

It would seem that this spot was once the site of a submarine volcano, from which the lower bed of pumice was ejected. The pumice slopes at an angle of 45° up the river, *i.e.*, northward, but it is clear this is not the result of movements from below, since the mud bed upon which the pumice rests is horizontal and undisturbed, which would not have been the case had it been upheaved by a movement which tilted the pumice into its present position. This mud stratum, and the stratum of mixed lapilli and mud above the pumice, are both destitute of fossils, although the tuff abounds with them, calcined as just described, and confusedly intermingled with the pumice, showing that they were hurled from their original bed into their present position with the pumice itself. The upper and non-fossiliferous stratum must, I apprehend, be referred to a later volcanic eruption.

What I have called volcanic mud is generally spoken of as ordinary clay, but a cursory examination will show it to be a volcanic product; the mere fact that beds of it perfectly destitute of fossils lie between beds of other composition richly endowed with remains of animal life is convincing. We thus gain an idea of the immense volcanic discharges, extending over a vast period of time, which must formerly have taken place in this region, and which, indeed, can only be said to be pretermitted at the present moment, seeing that the district lies within the range of the yet smouldering volcano of

Tongariro. The lowest stratum visible here is the red clay—a volcanic product. Then comes the pumice bed itself, extending miles and miles in length and breadth, a terrible witness of the vigour of a huge submarine volcano, whose effects were augmented here and there by lesser outlets, as in the cliff mentioned. A long interval of calm must have supervened to allow of the deposition of the blue clay, and the birth and death of the inhabitants of the many generations of shells which there lie buried. Another mud torrent from a distant point followed, rolling over the blue clay, entombing its molluscs, and covering it at Shakespeare Cliff with a layer ten or fifteen feet thick, and elsewhere of a much greater thickness. Again, volcanic activity ceased for a time, and for no brief period, since it was long enough to allow of the accumulation of a shelly stratum twelve to eighteen inches thick, with a large *Pectunculus* as its characteristic fossil. But it was only the prelude to a more terrible fiery storm. A perfect deluge of mud came down, forming a layer fifty feet thick, and covering perhaps as spacious an area as the pumice. Upon this lies three feet of marine clay, with recent shells.

Superimposed is a remarkable bed of dark cemented gravel, ten to fifteen feet thick, covered by twenty feet of loose grit, both without fossils. This bed of cemented gravel is exposed at Shakespeare Cliff, at the cliffs below Putiki called the Landguard Bluff, at the end of Victoria Avenue, and in several other places situated at a distance from each other, showing that it likewise spreads over a large tract. Was it the bed of a lake occupying the present valley of the Wanganui? It bears the aspect of a lacustrine deposit, and the overlying beds in the sections made by the roadmen in the cliffs at the west end of the town, all of which are non-fossiliferous, certainly seem to be of that character.

The gravel is capped by one hundred feet and more of volcanic mud, which in many places has suffered much from denudation. An indication is given of how denudation has lessened the thickness of this bed, and perhaps of the lower mud beds also, at the Landguard Bluff. There is a fault here, the bluff at the sea end having sunk about fifty feet, bringing the gravel bed down to the water's edge, yet the top surface of the cliff is level, proving that at least the depth of the fault has been denuded.

The foregoing remarks will give an idea of the force and long duration of volcanic eruptions in this region; but only an idea, because there is no section of country laid bare which reveals a full development of the series of eruptions and intermissions. That, of course, could hardly be expected. We find, for example, that the second shelly layer above the blue clay, which at Shakespeare Cliff is only from twelve to eighteen inches thick, expands at the Landguard Bluff to a stratum twenty feet thick, composed almost entirely of shells, a large *Pecten* (*P. jacobæus*) here playing the part which *Ostrea* does at

Shakespeare Cliff. At the latter spot the gravel bed lies immediately upon the shelly stratum, but at Putiki a soft red sandstone, non-fossiliferous, intervenes. In fact, the district through which the Wanganui flows in the lower part of its course contains a variety of local beds of limited area, and beds of fossils completely different in character occur within a short distance of each other, which, taken alone, might lead to the belief that the beds were of different ages. Their synchronism is, however, indubitably proved by their relative positions to the pumice, blue clay, and cemented gravel, which are constant members of the series throughout the region, and, moreover, the character of these fossils itself determines their age. It must be remembered that molluscs, although possessing an organisation extremely simple compared with that of many of the classes in the animal kingdom above them in rank, and a great tenacity of life, are remarkably susceptible to surrounding influences. An animal like the horse, with a highly complicated structure, can range over many degrees of latitude and longitude and country of varied nature without showing signs of being affected thereby, but to the humble *Patella* it makes a vast difference whether its home be in a tranquil cave or on the ocean beach, exposed to the constant buffetings of the polyphlœsbian sea. Every bay, every harbour, every strand has its peculiar molluscan fauna, and should the embryos of a new species be accidentally conveyed into a new habitat sufficiently hospitable to bring them to maturity, the form and appearance of that species are speedily modified by an unseen and silent working, but omnipotent, power into that fashion which best fits it for its new residence. You can verify these statements for yourselves by diligently examining and comparing the molluscs inhabiting Evans Bay with those of Lyall Bay, or of the inner harbour of Port Nicholson. When, therefore, we find the fossils of Shakespeare Cliff and of the Landguard Bluff differing considerably in species, though not in genera, while in the one genera are present which are absent from the other, we must not conclude their age to be different on these grounds alone; but the lithological character of the strata must be taken into account, and, above all, the *type* of the fauna. If that be similar in both cases, we may conclude that the age of the strata is the same. For while, from the Cambrian to the pleiocene eras, the multifarious forms of molluscan life so blend with one another that it is impossible to say where one ends and the other begins, still the naturalist who has made himself acquainted with the entire fauna *feels* that certain periods are distinguished from each other by the general type of their fauna, although, in the present imperfect state of human knowledge, he would be unable to describe in words the nature of that type. It is like the colours of the sky. Looking first at the zenith, and then at the horizon, we perceive clearly the difference of colour, but the intervening tints pass imperceptibly into one another, and no imaginary zones

of tint could be drawn, although were the human vision sufficiently acute the lines where each tint attains it maximum, and which give the tone to the whole sky, could doubtless be discerned.

I have collected from the Landguard Bluff a large assortment of shells, including *Pecten jacobæus*, *Tellina* (large and small species), *Cardita*, *Rotella zealandicus*, *Myadora*, a small and very fragile *Venus* (which I think is not catalogued), *Nucula*, *Fusus* (two species), *Turritella*, a small *Scalaria*, *Ostreæ*, *Lucina*, *Natica*, *Crepidulæ*, a large *Voluta*, *Rissoa*, *Venericardia*, and *Donax*, all, it will be observed, betokening a climate similar to the present. I refrain from attempting to give specific names, for the reason that I have not proper materials at command to determine them, and nothing has tended more to complicate the intensely perplexing nomenclature of shells than the hasty efforts of collectors to attach names to specimens which are not quite familiar to them.

Considering the abundance of cephalopods in the New Zealand waters of the present day, it is surprising that I have been unable to discover a single fossil of a cephalopod in the district, nor is one marked in the Museum catalogue. What does this indicate? The fossils collected show the climate to have been suitable for cephalopods, which, however, have a wide range, and some are very hardy.

From this sketch it would appear that the oldest fossiliferous stratum within a radius of four or five miles from the town of Wanganui is the tuff in the cliffs mentioned on the east bank of the river; the next oldest, the blue clay of Shakespeare Cliff; and the youngest, the beds overlying the blue clay and those at the Landguard Bluff—the strata thus growing older as they ascend the river. To ascertain the comparative ages of these formations would require the fossils of each to be examined separately, with the view of determining the proportions of extinct to recent shells. Captain Hutton, in his Catalogue, has lumped the three formations together, and thus makes them out to contain seventy-six per cent. of recent shells, which would make the beds of about the same age as the Sicilian volcanic tuffs (newer pliocene). It will probably be found that the lower beds are of the same age as these tuffs, perhaps a little older, but there is such a marked difference, palæontologically speaking, between the tuff bed on the left bank of the Wanganui river and the upper beds of Shakespeare Cliff, which are of very recent origin, that their fossils ought not to be mingled together in order to strike an average.

Art. LXXIII.—*Description of three new Tertiary Shells, in the Otago Museum.* By Capt. F. W. Hutton, F.G.S., C.M.Z.S.

Plate XXI.

[*Read before the Otago Institute, 12th October,* 1874.]

Cominella striata, sp. nov.

Fusiform; spire acute, produced. Whorls six or seven, convex, with small spiral ribs, and finely spirally striated between the ribs; upper whorls of the spire transversely ribbed; body whorl moderate. Columella with a few small teeth at the anterior end; aperture ovate; outer lip grooved inside; canal rather long, turned slightly backward, and notched. Length, 1·15; breadth, ·6.

Locality.—Wanganui, in blue clay.

Presented to the Museum by W. T. L. Travers, Esq., F.L.S.

Zizyphinus hodgei, sp. nov.

Thin; whorls flattened, suture obscure; outline of spire concave. Whorls angled with fine spiral moniliform lines, of which there are about five on the body whorl in front of the aperture from the suture to the keel. Columella with a small callosity over the umbilicus. Length, ·85; breadth, ·95.

Locality.—Wanganui, in blue clay.

Presented to the Museum by M. V. Hodge, Esq.

Venus (?) sulcata, sp. nov.

Ovate, sub-equilateral, rounded in front and obliquely truncated behind. Umbones slightly turned forward. Shell deeply and broadly concentrically grooved. Height, 1·9; length, 2·4.

Locality.—Napier, in limestone.

Presented to the Museum by Captain Hutton, F.G.S.

Art. LXXIV.—*Notes on the Microscopic Structure of certain Igneous Rocks submitted by the Director of the Geological Survey of New Zealand.** By Richard Daintree, F.G.S., Agent-General for Queensland. Communicated by Dr. Hector.

[*Read before the Wellington Philosophical Society, 8th August,* 1874.]

Dolerites.

No. 207*b*.—*(Selwyn River.)* Altered dolerite. The constituents are plagioclase, augite, magnetite, and pseudomorphs after olivine. The large brown

* These minerals were collected by Dr. Haast. The composition of several of them is given in the Seventh Annual Report on the Colonial Laboratory, 1872, p. 17.

patches appear to be cavities filled with the fine-grained basaltic portions of the rock.

No. IX.—*(Snowy Peak Range.)* Similar to No. 207*b*.

No. 410.—*(Haurata District.)* This rock differs from those classed under this head, as orthoclase and plagioclase are both present. The brown mineral is probably augite; the colours, however, as seen in polarized light are far less brilliant than usual.

The base contains an immense number of microlites, and exhibits well the "fluidal" structure. Under a ¼ inch objective the microlites appear of a clear yellowish brown; they are probably augite.

No. 218.—*(Flagstaff Hill Basin.)* This specimen consists of a fine-grained matrix composed of small grains and crystals of augite, plagioclase, and magnetite, in which larger crystals of olivine are imbedded.

No. 398.—*(Haurata District.)* Contains the same minerals as No. 218, together with slender acicular crystals of apatite.

The olivine has been much decomposed, and hydrous ferric oxide in some cases only remains.

No. 204.—*(Acheron Section.)* A weathered specimen. The felspar is very much altered; some appears to be orthoclase. There are many long prisms of apatite, and the small hexagonal crystals are the transverse sections of the prisms.

Trachytic Rocks.

No. 308.—*(Mount Misery.)* Contains crystals of quartz and orthoclase in a compact felsitic base.

No. 358.—*(Snowy Peak Range.)* A similar rock of greenish colour. In addition to the quartz and felspar it contains a few garnets.

No. 359.—*(Snowy Peak Range.)* This appears to be the same as No. 358 in a fragmental condition, produced probably by the crushing action of the mass when in motion at the time of eruption.

No. 366.—*(Snowy Peak Range.)* This rock contains crystals of quartz and orthoclase, a few grains of garnet, and a little brown mica. It exhibits the fluidal structure very well, and, as part of the base is a structureless glass, it may be regarded as intermediate between felsite and pitchstone.

Granitic.

No. 348.—*(Snowy Peak Range.)* Consists of orthoclase, a considerable quantity of plagioclase (probably oligoclase), and a little silvery mica.

There is a yellowish mineral with a fibrous radial structure seen both in the specimen and section. It is evidently a secondary formation, filling spaces between the constituents. It is probably prehnite.

Pitchstones.

No. 349.—*(Snowy Peak Range.)* Contains crystals and crystalline grains

of orthoclase and quartz. The matrix in which they are imbedded is a structureless glass, densely crowded with an immense number of very minute yellowish brown granules, nearly uniform in size, and quite translucent. Black grains of magnetite are also scattered through the mass. The section cut contains a pale red crystal of irregular form, which exhibits no double refraction—it is evidently garnet.

Some of the orthoclase contains numerous cavities filled with brown glass, and one of the quartz crystals contains a characteristic rhomboidal cavity with a vacuity and five or six belonites.

The "fluidal" structure, as it has been called, is remarkably well shown; streams of microlites and brown glass bend round the larger crystals, and clearly indicate the plastic condition of the mass subsequently to their formation.

No. 353 *(Snowy Peak Range)* is a rock of quite similar character.

Art. LXXV.—*Deep Sinking in the Lava Beds of Mount Eden.* By J. C. Firth.

[*Read before the Auckland Institute, 26th August,* 1874.]

Early in 1873 I commenced sinking a well in my grounds at Mount Eden, with the view of obtaining a constant supply of water. I was led to undertake this work from the circumstance that at various points around the mountain springs of excellent water are met with. The most notable of these is the spring found by Mr. Seccombe, yielding in the driest seasons about 80,000 gallons daily of most excellent water.

I do not know that a record of my explorations will present any features of much interest to the general public. To myself, though unsuccessful in my search for water, they were full of interest, for, as I penetrated each successive lava stream, it seemed like the turning over of the leaves of some ancient and unknown book. I am disposed to believe I have obtained a few facts which may, in the hands of scientific men, be of some little use in helping them to elucidate some of the phenomena which in bygone times have played so great a part in changing the features of the land we live in. The point of commencement was 329 feet above sea level, and 313 feet below the summit of the mountain. The depth to which I penetrated was 212 feet, or within 117 feet of sea level at high water mark, or about thirty feet below the bottom of Mr. Seccombe's well before referred to.

The accompanying section presents the thickness, position, and details of the successive beds of volcanic ash and lava through which I passed:—

Seventh and latest eruption.

			Ft.	in.
Brown soil and scoria stones intermixed ...	...	...	12	0
Blue scoria rock with patches of quartz.	18 feet	...	6	0

Sixth eruption.

			Ft.	in.
Loose scoria stones with crevices from which issued blasts of cold air; stones covered with soft mud ...	...	...	12	0
Loose red scoria ash with round nodules of very dense scoria covered with cement deposits; steel grey fracture, showing abundance of olivine and brilliant coloured crystals ...	...	...	8	0
Hard blue rock with patches of quartz ...	...	...	4	0
Solid blue rock, close-grained, basaltic.	50 feet	...	8	0

Fifth eruption.

			Ft.	in.
Loose boulders in coarse red scoria ash, pieces of quartz imbedded; full of crevices, through some of which came strong currents of pure cold air. Stones and ash filled with moisture		...	42	0
Hard blue rock.	101 feet	...	9	0

Fourth eruption.

			Ft.	in.
Red and sulphur yellow ashes and very porous rock ...		...	4	0
Very close-grained hard blue rock ...	...	...	12	0
Stratified basaltic rock, dipping from S. to N. at an angle of 30°		...	6	0
Solid blue rock with quartz.	132 feet	...	9	0

Third eruption.

			Ft.	in.
Red scoria ashes and rough clinker cinders	...	...	36	0
Hard bluish rock	...	...	4	0
Hard close-grained rock—Indian red colour	...	...	2	0
" " " Blue colour.	176 feet	...	2	0

Second eruption.

			Ft.	in.
a. Baked clay with round holes in which fern roots had been imbedded	...	...	1	0
Fine scoria gravel	...	...	0	6
Red hard scoria, much honeycombed ...	...	...	2	0
Hard close-grained blue rock.	180 feet 6 inches	...	1	0

First eruption.

			Ft.	in.
b. Volcanic mud, full of holes (the impress of timber decayed)		...	2	0
c. Soft sandstone rock of light yellow colour, stratified ...		...	1	6
d. Ochre, like Venetian red of a bright vermilion colour		...	1	6

Black scoria rock, intensely hard, full of air-bubbles or honeycombed. For 2 feet intersected by seams or joints transverse and vertical. These seams were filled with the vermilion-coloured earth. This rock presented every appearance of having been deposited under

	Ft.	in.
water, and had contracted in every direction, showing cracks as above described. This black rock continued without any change to the furthest point reached, viz., 212 feet from the surface ...	26	6
	212	0

At this point, there being no indications of a change, nor any signs of water, I brought my explorations to a close.

I have arrived at a few conclusions, which I submit with diffidence, yet, as they are based upon evidence carefully noted as the explorations proceeded, it might be unwise to omit them from this paper. In noting these conclusions, and such evidence as may be necessary, I shall, for obvious reasons, commence at the earliest eruption and ascend to the latest.

The lowest lava bed penetrated 26 feet 6 inches, and presented strong indications of having been a submarine eruption. Upon this rock there appears to have been deposited (at *d*) a substance like Venetian red. This, I think, had been deposited under water. Whilst in this position it had apparently been washed into the numerous joints or seams to the depth of several feet, which I have described as appearing in the upper surface of the lowest lava stream. Upon this red stratum there lay, dipping at an angle of about 45° S., or towards the mountain, 18 inches of a soft sandstone rock of a light yellow colour (*c*), having a well-defined stratification, as though the formation had been deposited under water. Though this deposit on analysis showed a trace of chloride of sodium, I am inclined to think it was deposited in fresh water, as if a fresh-water lake had been formed in the ancient crater subsequent to its elevation above sea level. I am the more disposed to advance this opinion, because I have been unable to detect any traces of marine shells or plants in this formation, whilst I found in it some extremely beautiful and well-defined impressions of leaves of toetoe (*Arundo conspicua*) or of raupo (*Typha latifolia*). Both these plants love moist ground; the latter does not grow except in fresh water, either in very wet swamps or around the edges of fresh-water lakes, instances of which may be seen in the crater of Mount St. John and in the ancient crater now known as Lake Takapuna.

Resting upon this sandstone formation I found a deposit of two feet thick of a mud rock, similar in colour to the preceding stratum, but without any appearance of stratification, in which were many cylindrical holes lying more or less in a horizontal or inclined position.

These holes, of all diameters from half an inch to nine inches, clearly represent the branches and trunks of trees, as if a shower of mud and fine ashes had fallen from the volcano upon a young forest, or (which I think more probable) upon drift wood deposited at this and probably other points in the

fresh-water lake I am assuming to have occupied at this period the ancient crater. Almost every particle of the wood had decayed, except patches of bark adhering to portions of the cylindrical holes or matrices I have already described. So closely had the mud rock taken the impress of the trees, that I observed wherever a branch had been broken the most exact impress remained in the mud rock. Strata *b*, *c*, *d* represent the bottom of the ancient lake, at the lowest point of which will probably be found the stream which discharges into the Waitemata at Messrs. Low and Motion's mills, and known as the Western Springs. At some future date I may perhaps put down what miners call a "winze" on the dip of strata *b*, *c*, *d*, with the twofold view of obtaining more information regarding the waters of Mount Eden, and of bringing to light some of the plants and denizens of older times.

To return. Upon this mud rock there lay a stratum or lava stream of hard close-grained blue volcanic rock; and upon this again a stratum two feet thick of hard red scoria rock much honeycombed, followed by six inches of fine equal-sized scoria gravel.

These latter strata probably represent the first eruption of Mount Eden subsequent to the appearance of the more ancient crater above sea level, filling up the crater lake, and causing the superposed lava streams to dip at an angle of 25° from the mountain to N., or in the opposite direction to the dip of the lava stream below.

Lying on this I found a stratum (*a*) dipping at about 25° to N., one foot thick, of a reddish yellow clay, perforated with holes from $\frac{1}{8}$ inch to $\frac{3}{4}$ inch, perfectly round, smooth, and slightly taper; in some instances containing a woody fibrous-like matter, doubtless remains of the stringy filaments of fern root. On being touched these filaments fell away to a white ash. The fern roots growing on the surface exactly fitted these holes. All traces of the plants had disappeared, leaving only the impress of their roots in the baked clayey soil. Upon this lay a two-feet stratum of hard blue close-grained scoria rock; and upon this again a stratum of similar thickness of compact red scoria. It will not be necessary to continue to trace upward the various strata through which I passed, as they are fully described in the section.

In conclusion, I may say that during the exploration I had passed through five distinct eruptions before I had sunk to the depth of 176 feet. From the total absence of vegetable matter, or of any traces of decomposition of ash or rock, I conclude that these five eruptions followed each other at very short intervals. At 176 feet, as will have been seen, I came upon a deposit of volcanic mud, or possibly a decomposition of ash, showing a much longer interval of time to have occurred between this eruption and the first of the five subsequent ones. This eruption, occurring at a depth of about 180 feet from the present surface, probably filled up the lake occupying the crater of a

still more ancient volcano. This eruption, the first of the seven lava streams, undoubtedly occurred long prior to the second eruption, as shown by the three feet six inches of sandstone and mud in which the plants and forest were embedded. As to the period at which the latest eruption of the Mount Eden volcano occurred, we may conclude, from the twelve feet of brown soil found at the existing surface, that many centuries have elapsed since the last volcanic action.

In ages long past there can be little doubt that the sea flowed across what is now the isthmus on which Auckland on the east and Onehunga on the west stand, dividing what is now the North Island into two islands. Volcanic forces of tremendous power and long-continued action elevated the isthmus as we now see it, leaving the extinct volcanic cones of Mount Hobson, Mount St. John, One Tree Hill, and Mount Eden as mementos of the grand volcanic energy of former times.

Whether these extinct volcanos will yet again become active, time alone will tell.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

FIRST MEETING. 18*th July*, 1874.

Charles Knight, F.R.C.S., President, in the chair.

New members.—E. F. Burrell, George M. Wink, C.E., Hon. William Fox, M.H.R., Alexander Kerr, F.R.G.S., Alexander McKay, Thomas Kirk, F.L.S., Charles Holmes Borlase, John Newton Coleridge.

Before the business of the evening was formally entered upon, Dr. Hector introduced to the society Dr. Berggren, of the University of Lund, who is at present engaged in making a botanical exploration of New Zealand, and Mr. Joseph Holloway, agent for the Agricultural Labourers' Union, who is making a tour of observation through the various Provinces for the purpose of furnishing a report upon the suitability of New Zealand as a field for immigration.

Publications received from Harvard College, the Smithsonian Institution, and the Geological Society of Florence were laid on the table.

There were also laid on the table a number of marine specimens, presented to the Colonial Museum by the gentlemen belonging to the "Challenger" expedition, and a microscope with mounted slides for showing the nature of the bottom of the sea between New Zealand and Australia, as evidenced by specimens obtained from the soundings made by the "Challenger."

The President delivered the following anniversary

ADDRESS.

It has been the custom for your Presidents in their annual address to notice the papers discussed at the Society's meetings during the year. I find it difficult to make such notices interesting. Indeed, it is the most valuable papers that are the most difficult to comment on, except in general terms of praise. Take Mr. George's paper on the Patent Slip at Evans Bay—the first of our papers in the Transactions of the Institute—it is over-running with valuable suggestions for engineers; or turn to the end of the volume, we have Captain Moresby's Lecture on New Guinea; certainly in this last case I may tell you that Dr. Macleay visited the Astrolabe Gulf in the years 1871 and 1872, and studied the inhabitants of the whole coast of that Gulf, and the dwellers on the islands near Cape Duperré, and speaks of them, as Captain

Moresby did of those he met, as living a life of such perfect happiness that he called the islands "The Archipelago of Contentment." As regards the characteristics of races, it may be interesting to note, in connection with Captain Moresby's description, that the Papuans have the upper teeth projecting considerably beyond those of the lower jaw, and, contrary to what is usually stated, there is no such roughness of the skin as would constitute a race characteristic. The colour of the skin, too, is in general of a chocolate brown—not of a bluish-black colour, as has been previously asserted; and the hair of the head is not naturally disposed in tufts or clumps, but grows just as it would upon the head of a European. Mr. Galton, from whose review I have culled the above remarks, completes the picture by observing that the Papuan maidens begin, even at the tender age of seven years, to cultivate the art of which Mr. Turveydrop was the distinguished professor.

You will find at page 391 of the Transactions for 1873, a short notice of a discussion on Solar and Terrestrial Radiation, introduced by Mr. C. R. Marten, who explained that the black bulb thermometer in Southland frequently ranged as high as 170°, being 30° higher than in Sydney, and much higher than it has ever reached in the North Island.

As some doubts are implied in the printed report of the correctness of the readings, I wish to state that Mr. Marten is not only an enthusiast in meteorological pursuits, but a most painstaking observer, with whom my duties as first Director of Meteorological Stations in New Zealand brought me in very pleasing communication. As this is a subject on which I formerly took much trouble, and may claim for myself the merit of having established all the principal Meteorological Stations in New Zealand, and as it was a great comfort to have the co-operation of Mr. Marten, I am anxious to explain why I believe the observations referred to are correct. Of course we all know how difficult it is to prevent "cooking" of observations. In looking over my correspondence with a distinguished savant who had a great deal to do with getting up meteorology in India, he notices how discouraging it was to work at the results of people who had no training in the use of instruments. The stupidity of some observers is impregnable. An intelligent, well-educated man supplied him a long series of *wet-bulb* observations obtained by holding a thermometer *under water* and reading off—the bulb was wet, what more could be wanted! You will understand, then, the comfort, in starting a number of Meteorological Stations, of having a Member of the Meteorological Society of England for a coadjutor.

I did not join in the discussion further than to inquire what was the vapour tension at the time those high indications of the black bulb thermometer were taken. I shall explain why I asked for that information.

The black bulb thermometer is always exposed, for observation, to the

direct rays of the sun. The *calorific* rays of the sun pass through air devoid of aqueous vapour with no appreciable loss; but if water in the form of invisible vapour be present, the air is not perfectly transparent to those rays, and offers, I believe, a slight obstruction to their passage. It is almost opaque to radiant heat from the surface of the ground. Transparency to heat and light is witnessed in the passage of the sun's rays through the glass windows of our dwellings. The heat in a close room into which the sun shines may be overpowering, while the glass, through which the whole of the heat has passed, remains cold. The greater the proportion of aqueous vapour the more solar heat is absorbed in its transit through the atmosphere. Now, the quantity of vapour in the air depends mainly on temperature. In the colder regions of the south, although the air may be saturated with vapour, the relative proportion of vapour to air is much less than in tropical climates; and thus it happens that in Southland less of the sun's heat is lost in its passage to the earth. For instance,—the quantity of vapour in air at a temperature of 90° Fahr. is four times as great as in air at 50° Fahr.; and the consequence of its being loaded with vapour at the higher temperature is a slight obstruction of the passage of the sun's rays; and were it not that they strike in Southland with a somewhat greater obliquity than in Sydney, and thus traverse a greater mass of air, it is possible that these high readings of the black bulb thermometer would more frequently happen in the southern parts of the South Island.

Dr. Hooker, in his observations on the climate of the Himalayas, states that at a height of 10,000 feet at 9 a.m. in the middle of summer the thermometer mounted to 132° Fahr. in the sun when the temperature of the air was 32° Fahr., a difference of 100°. This difference, no doubt, would have been much greater had the black bulb been protected from currents of the surrounding cold air, and had it laid on a bed of black cotton-wool. Tyndall quotes this for the purpose of showing that the extraordinary difference of 100° can only be accounted for by the sun's rays passing through air almost devoid of aqueous vapour as through a vacuum. Dr. Hooker found the same extraordinary difference on the plains of India, because of the dryness of the air; but no such result had been found in Calcutta, where the heated atmosphere is surcharged with aqueous vapour. Tyndall goes on to say that he himself "never, under any circumstances, suffered so much from heat as in descending on a sunny day from the Corridor to the Grand Plateau of Mont Blanc. The air was perfectly still, and the sun literally blazed against him and his friend. Though hip deep in snow, still the heat was unendurable."

What I contend for is, that in high latitudes the air does not contain the same quantity of aqueous vapour as in warmer latitudes. That the presence of aqueous vapour interferes in a slight degree with the passage of solar heat,

and this slight obstruction affects the black bulb so as on rare occasions to render the readings no higher in Sydney that in Southland. And I may add, as a "rider" to the above, that those who contend that the atmosphere, whether charged with vapour or not, is a vacuum to the sun's heat rays, are left with no explanation of the heat being diminished when that luminary is low down in the heavens.

In connection with the Meteorology of New Zealand, I wish to offer an explanation of the Hot Winds of the Canterbury Plains. The N.W. dry, hot winds of Australia, in their passage over the ocean, become surcharged with vapour at the expense of a noticeable part of their heat. In the philosophic language of the day, the heat of the air is made to do work by converting water into vapour, and by maintaining it in that state. The sensible heat thus absorbed by vapour is converted into latent heat—that is, the heat is not lost, but is engaged in the veiled work of maintaining water in an invisible state. The air in thus dissolving water becomes a carrier, or distributor of heat. It is not difficult to give an approximate estimate of the quantity of heat made sensible to the thermometer by the reconversion of vapour into water. The problem has been solved by experiments, and it is found that the amount of heat stored up in aqueous vapours from one pound of water is sufficient to heat 1000 pounds of water one degree of Fahrenheit, or, as Tyndall puts it, to fuse five pounds of cast iron.

Next as to the phenomena arising out of the fall of heavy rains on the flanks of the ranges on the West Coast. The quantity of heat liberated would be considerable did not other causes interfere with its escape. The rain itself carries down with it a small part of the sensible heat, but the greater portion of that set free is at once taken up by the atmosphere in rising to the altitude of the lofty ranges in its passage to the plains of the South Island. The sudden rarefaction is due to the loss of pressure of the column of air lying between the level of the sea and the average height of the ranges. This dilatation is accompanied by what used to be termed an increased capacity for heat, so that heat is absorbed by the air itself. This too, in the current phraseology of the day, is called work done at the expense of heat. So that altogether we have a diminution of *sensible* heat, but not an actual loss of heat, by the passage of the air over the ocean, and next by the rarefaction of air in its ascent to the higher regions of the ranges. When air expands by reason of the loss of pressure, the undulations of the molecules of air, which we term heat, diminish also—or, in other words, the amplitude of the vibrations is diminished, and the distance between the undulations increased. Motion imposed on the molecules of matter would go on for ever, just as any motion imposed on a mass would never cease, if there were no medium through which it could communicate its motion to other bodies, or in some other way exhaust

itself. This inertia belongs to molecules as much as to masses. While the swing of the molecules is diminished, and the distance between the undulations is increased, the actual force, which we call heat, remains undiminished. It is only necessary that the undulations should be again crowded together in order that the energy may be restored.

So far I hope that I have made my meaning clear,—that air in taking up moisture loses sensible heat. No one who has travelled on the West Coast of the South Island can have failed to notice when he leaves the forest road, and comes on the dreary sands of the coast, with a moderate sea breeze, how miserably cold the air is in the immediate vicinity of the breakers. This is owing to absorption of sensible heat by the solution of the spray in the current of air sweeping over the sea.

Next, in reference to the heat gained, if any, in the passage of the air over the extensive elevated region between the West Coast and the Canterbury Plains. The air on the mountain ranges gains no addition of temperature from the direct radiant heat of the sun, for the rarefied air is, to use a technical expression, almost transparent to the sun's heat rays—it permits them to pass with very slight loss. The sun warms the ground but not the air. It is not so, however, with the heat radiating from the surface of the ground—this is almost entirely absorbed by the atmosphere, which thus gains sensible heat until at length it reaches the eastern slopes of the mountain ranges.

Here, where the column of air begins its descent to the plains, we ought to have a complete reversal of every phenomenon that accompanied its passsage from the level of the sea on the West Coast till it reaches the elevation of the mountain ranges. As the column of air sinks down, the increased extent of the vertical column gives increased pressure, and compresses more and more the lower stratum—the latent heat becomes sensible and the thermometer rises. But it is necessary that I should give you here some proof that increased pressure adds to the energy of heat in aeriform bodies, or, in the old expressive phraseology, converts the latent heat into heat recognised by our senses, and registered by the thermometer. Airy has explained that when the changes of volume and pressure are very rapid, the changes of temperature of the air are very great:—"Upon suddenly condensing air it becomes very hot. We have verified the experiment, that if inflammable tinder is placed in the bottom of a cylinder in which a piston fits tightly and slides easily, when the piston is driven rapidly down so as to condense the air very much before it has time to impart the whole of its heat to the surrounding metal, the air will inflame the tinder." And Airy remarked, "in the powerful air pumps (driven by large steam engines) which were used to exhaust the air tubes upon the atmospheric railway, that when the attenuated air in the tube, having acquired the temperature of the ground, was compressed by the operation of pumping

so as to be able to open the last valve in opposition to the pressure of the atmospheric air, the emergent air was so hot as to be unbearable to the hand. If the heated air, without having lost caloric, be allowed to expand to its former dimensions it exhibits its former temperature; that is, it cools by sudden expansion. And this is so well known that it has been proposed to supply apartments in hot climates with cool air, by compressing air in a close vessel, allowing the increased heat to escape by contact of the vessel with the external air or neighbouring substances, and then permitting the condensed air (at the atmospheric temperature) to expand into the apartments, when it would have a much lower temperature."

You see at once that the condition of the air in the tubes of the atmospheric railway bears the closest relationship to what takes place in the transit of the air from the West to the East Coast. First, the rarefaction of air in the tubes;—this represents the expansion of air in its ascent to the mountain ranges. The subsequent compression of air, for raising the escape valve is analogous to the descent of the column of air from the ranges;—and the escape of the hot air at the valvular opening is a counterpart of the heated air sweeping over the Canterbury plains.

A paper on the Preservation and Treatment of the Timber of New Zealand, by Mr. Buchanan, of the Geological Survey Department, is deserving of some notice.

The forests of New Zealand are cut down recklessly at all seasons of the year; and when the trees are sawn into square timber or planks no attempt is made to preserve them against decay or deterioration.

Greater attention should be paid to seasoning. I am doubtful whether we do not, however, attach too great importance to the time of the year in which the trees are felled. If cut down in summer they should be allowed to lie where they are felled, and no branches cut off, so that the sap may be dried off by evaporation from the surface of the leaves. Unless this be attended to, the timber from trees cut down in summer, and immediately sawn up, will be much deteriorated in value—the planks will warp and the larger timber will split and spoil from hasty drying.

On the whole, it is safer that the trees should be cut down, or killed by "ringing," during the winter months. As soon as possible after being felled they should be cut into square timber and planks, and these stacked in a proper manner, and carefully protected from the sun's rays.

Timber so cut, seasoned, and protected, might be branded as a guarantee to purchasers. The letter of the brand would show the year in which the timber was felled, just as silver plate is lettered to show the year in which it was stamped.

With respect to ringing trees which exude large quantities of gum from

the cut surfaces, I am decidedly of opinion that the loss of gum would be followed by a loss of power in the timber to resist decay, and that in such instances "ringing" is objectionable.

One great advantage of charring the lower end of posts is that the sap is dispersed at that end. If, in addition to charring, the heated end is immediately plunged into cold tar, made more liquid by the addition of kerosene, I think the post below the ground would be almost indestructible. The moisture left in the charred end, when the post is first removed from the fire, would be in form of steam, and on its condensation by the cold of the tar bath in which it is plunged would produce a vacuum into which the tar would be forced by atmospheric pressure.

I may mention that careful experiments have been made in the United States of America by Generals Cram and Gillmore, and the result of their investigations is, that Seely's process is the best. It consists in subjecting the wood to a temperature above the boiling point of water and below 300° Fahr., while immersed in a bath of creosote a sufficient length of time to expel the moisture. When water is thus expelled the pores contain only steam; the hot oil is then quickly replaced by a bath of cold oil, by means of which change the steam in the pores of the wood is condensed and a vacancy formed, into which the oil is forced by atmospheric pressure and capillary attraction.

I find that in California they are already alarmed at the rapid destruction of their forests, containing the largest and finest trees in the world. It is estimated that one-third of all the available timber has been consumed, and that the whole of the available timber will be consumed in twenty years. One of the worst features of the settlement of new countries is the reckless way in which the timber is destroyed. Not only is the practice condemned in severe terms by thoughtful men in California, but the opinion must be gaining ground that the State should interfere. The only remedy seems to them to be for the Legislature to take up the matter, and by proper laws to provide not only for the preservation of the forests, but for the planting of trees *pari passu* with the settlement of the country.

It is maintained by writers on the subject in America, that at least one-third of the surface of any country should be forest—that this proportion between clear land and forest is one which will secure the greatest results in an economic point of view. It is also insisted upon that a fertile country, if stripped of its forests, may be half overwhelmed by desolation from the consequent change of climate. That, in fact, a country so denuded of rain-gatherers is either dried up in summer or the soil is washed off from the hill-sides by the heavy rains of winter. Marsh, speaking of the destruction of forests upon the different countries of the earth, says:—"There are parts of

Asia Minor, of Northern Africa, of Greece, and even of Alpine Europe where the operation of causes set in action by man has brought the face of the earth to a desolation almost as complete as that of the moon. The destructive changes occasioned by the agency of man upon the flanks of the Alps, the Apennines, the Pyrenees, and other mountain regions in Central and Southern Europe, and the progress of physical deterioration, have become so rapid that in some localities a single generation has witnessed the beginning and the end of the melancholy revolution."

I know no sight more sad than to witness the destruction by fire of forests on the hill-sides—those mournful streaks sweeping along the more accessible sides of the ranges, with blackened trunks like Banquo's ghosts here and there in the midst—without parallel the most melancholy spectacle of wasteful destruction. I have doubts of the probability of much immediate good being effected in the way of planting in the permanent settled districts of the Colony. But there can be no doubt of our power to stay the destruction of forests on the ranges and on other lands not well adapted for agriculture. Here we have unquestionable means not only of staying wanton destruction, but of securing the successional growth of trees to make good the full grown timber when removed. To plant land with valuable timber is a slow process—to preserve what we have is surely our duty. It is on the ranges and highly broken ground that the timber is most effective in ameliorating a climate and of feeding the streams from which the plains may be irrigated.

The most interesting of our papers is that by Dr. Hector on the huge Fossil Reptilian Remains lately discovered in the South Island. That memoir has a value for all time. As a contribution to the knowledge of those enormous reptiles it will certainly engage the careful study of scientific men both in Europe and North America. Contemporaneous with these discoveries we find, from the report of Cope, that similar skeletons of these monsters of the ancient seas are being found in the cretaceous strata of the Kansas, in North America.

"If the explorer of these plains" (on whose level surface, denuded of soil, may be found huge oyster shells not less than two feet across, some opened, like remnants of a half-finished meal of some titanic race, who had been frightened from the board never to return) "searches the ravine he will," says Cope, "come upon the fragment of a tooth or jaw, and will generally find a line of such pieces leading to an elevated position on the bank, where lies the skeleton of some monster of the ancient sea. He may find the vertebral column running far into the limestone that locks him in his last prison; or a paddle extended on the slope as though entreating aid; or a pair of jaws lined with horrid teeth, which grin despair on enemies they are helpless to resist; or he may find a conic mound on whose apex glisten in

the sun the bleached bones of one whose last office has been to preserve from destruction the friendly soil on which he reposed."

The *Leiodons*, parts of whose skeletons are seen in our Museum, were of enormous length, varying from thirty to one hundred feet; "their heads were large, with eyes partly directed upwards; they were furnished with two pairs of paddles like the flippers of a whale; they were furnished with formidable teeth for seizing their prey." The physiognomy of the giant species in our collection was rendered peculiar by a long projecting muzzle. Cope once found the "wreck of an individual of the *Leiodon proriger* strewn around a sunny knoll beside a bluff, and his conic snout pointing to the heavens formed a fitting monument, as at once his favourite weapon and the mark distinguishing all his race." And here I must quote from Cope a peculiarity of these creatures by which they are unique among animals, but which I do not see alluded to in Dr. Hector's elaborate report. Nor can I satisfy myself that it could have existed in the reptiles whose fossil remains are in our Museum :—"In swallowing their prey like snakes, they were without that wonderful expansibility of throat, due in the latter to an arrangement of levers supporting the lower jaw. Instead of this each half of the lower jaw was jointed nearly half way between the ear and the chin. This enabled the jaw to make an angle outwards, and so to widen by much the space enclosed between it and its fellow. The ends of these bones were in the *Pythonomorpha* only bound by flexible ligaments. The outward movement of the basal half of the jaw necessarily twists in the same direction the 'quadrate' or column-like bone to which it is suspended. The peculiar shape of the joint by which the 'quadrate' bone is attached to the skull depends on the degree of twist to be permitted, and, therefore, to the degree of expansion of which the jaws were capable. As this differs much in the different species, they are readily distinguished by the 'quadrate' bone when found. There are some curious consequences of this structure, and they are explained as an instance of the mode of the reconstruction of extinct animals from slight materials. The habit of swallowing large bodies between the branches of the under jaw necessitates the prolongation forward of the mouth of the gullet; hence the throat of the *Pythonomorpha* must have been loose and almost as baggy as a pelican's. And the tongue," continues Cope, "must have been long and forked, and for this reason its position was still anterior to the glottis, so that there was no space for it except it were enclosed in a sheath beneath the windpipe when at rest, or thrown out beyond the jaws when in motion. Such is the arrangement in the nearest living forms, and it is always in these cases cylindrical and forked."

The Transactions of the New Zealand Institute show by numerous papers how actively the minds of our geological friends are engaged on the subject of

the Glacial Period. It is the fashion of the philosophy of the day to ascribe much of the moulding of our hills and valleys to the denuding power of ice—more in fact than one is inclined to admit.

Professor Phillips, at a late meeting of the British Association, remarked that one is almost frozen to silence in presence of the vast sheets of ice which some of his friends, followers of Agassiz, believe themselves to have traced over the mountains and vales of a great part of the United Kingdom. He refuses to accept the proposition that these "ice-rubbers" plough out the valleys and lakes, until we possess more knowledge than has yet been attained regarding the resistance offered by ice to a crushing force, seeing that under a column of its own substance 1000 feet high it would not retain its solidity.

I have alluded to Phillips' opinion, because I see in Geikie's late work that reference is made to the fact that from the foot of glaciers in Greenland streams of water issue and unite to form considerable rivers, one of which, after a course of forty miles, enters the sea with a mouth nearly three-quarters of a mile in breadth—the water flowing freely at a time when the outside sea was thickly covered with ice.

This flow of water, Geikie thinks, probably circulates to some extent below every glacier, and he accounts for it by the liquefaction of ice from the warmth of the underlying soil. I am sure you will find a more natural solution of this flow of water from glaciers—estimated not less than 3000 feet thick—in the suggestion first made by Professor James Thomson, and subsequently proved by his brother, Professor W. Thomson, that the freezing point of water is lowered by the effect of pressure 0·23° Fahr., or about a quarter of a degree for each additional atmosphere of pressure. Now, a sheet of ice 3000 feet thick is equal to a pressure of eighty-three atmospheres, at which pressure it would require a temperature of 19° below freezing point to retain the form of ice. In the state of running water below the glacier, it might readily, as Geikie states, absorb heat from the underlying soil sufficient to retain its liquid form, as the overlying weight gradually lessened at the edge of the glacier. In this, too, we have a safe assurance that these enormous thicknesses of glaciers can exist only where there is scarcely any or no inclination of the land to the sea board, and that no sheets of ice of such enormous thickness could possibly exist on the sides of mountains, as they would have between them and the mountain side a stratum of water; and, to use a common expression, would come down "on the run."

And this may well make us hesitate to adopt with Geikie the views of the Swiss glacialists, who, I gather from Geikie's late work, speak of sheets of ice having existed in the great Ice Age not less than 3000 feet thick, overtopping the Jura, and stretched continuously from the Rhine Valley; and Geikie adds,

that no one can believe that this great glacier stopped on the banks of the Rhine.

I do not deny that sheets of ice 3000 or 5000 feet thick exist. I shall maintain, however, as an established fact, that ice if at the temperature of 32° Fahr. throughout cannot support a column of its own substance 3000 feet high. Nevertheless, a 3000 feet sheet may exist, although the temperature at the *surface* of the ice is only 32° Fahr., but in this case the temperature at the base cannot be higher than 13° Fahr. I will explain myself. The specific heat of water is far greater than ice. One pound of ice at 32° Fahr. mixed with one pound of boiling water gives two pounds of water at 51°; so that seventy-one degrees of heat have been lost in the mere conversion of ice into water. We thus see that every pound of ice converted by pressure into water demands a large supply of caloric, as a necessity of its change of condition, and absorbs it instantly from the ice in contact with it above. The ice in the immediate vicinity of the layer of water, hardened by loss of caloric, stops for the moment the further conversion of ice into water. But this state of matters continues only momentarily, the ice below, in its turn, robs the ice above of caloric, and this softened is unable any longer to bear the pressure, and flows away as water; and so the process extends, until a regular gradation of temperature is progressively but uninterruptedly established throughout the mass, and an equilibrium formed between the forces by which the sheet of ice maintains a fixed altitude. That is, we shall have a gradual fall of temperature from 32° on the surface to 13° at the base, the latter degree being the temperature at which ice will sustain a column of 3000 feet. I further maintain that no such column as 3000 feet can continue at that height for an indefinite time, unless the temperature of the air is much lower than 32°, because the temperature, if higher than 13°, would gradually creep down to the base of the column of ice, where the lowest stratum would continually melt away in the form of running water.

And we thus see, as a necessity of the case, that all thick glaciers have running streams at their foot.

I have brought this under your notice this evening, because no satisfactory explanation has hitherto been given of the cause of running water at the foot of glaciers, nor how it is that sheets of ice 3000 or 5000 feet thick are enabled temporarily to maintain their thickness.

Dr. Haast, Mr. Travers, and Captain Hutton have given much interest to the subject. The origin and formation of the Canterbury plains have led to the discussion.

Captain Hutton has come to the conclusion that the formation of the Canterbury plains is due to the action of the sea. His argument is, that the plains rise gradually from the sea board with a gentle slope—that in places

they warp round the spurs of the hills at the same level—and that no engineering power could form such level and extensive plains with their beds of water-worn shingle but the ocean itself—that the singular fact that the Hurunui and Canterbury plains are on the same level, is, in his opinion, an irresistible proof of the correctness of his views. I need scarcely add that if this view be correct there has been an elevation of the land of about 2000 feet.

Dr. Haast, on the other hand, assumes as sufficient for his views that glaciers of enormous size have moved down from the mountain ranges, and ploughed from the mountain sides the drift with which they have covered the more insignificant hills and formed the plains—that when the glacier outlets ceased to flow and to deposit any more boulders and gravel, the rivers cut through the deposits until they reached the harder rock on which the deposits reposed.

The necessities of this explanation require the admission that a glacial period formerly existed in the southern hemisphere—such as is generally admitted to have once existed in the northern hemisphere.

The weak point of Haast's theory is, that it does not account for the distribution of the drift so as to form regular plains. It seems to me impossible to confound the irregular pell-mell deposition of glacial drift with the evident stratification, through the agency of water, which exists in the Canterbury plains. And I observe that Jukes, speaking of the glacial deposits in the lowlands of Scotland and Ireland, and in the northern parts of England, even as far south as the northern margin of the Thames Valley, states that he has not the slighest doubt that they were stratified under the sea, notwithstanding the absence of sea shells from the greater part of them.

Mr. Travers objects to Dr. Haast's assumption of a glacial period, because of its remarkable character, and because we have no evidence whatever that such a change of climate as this supposes ever took place. Mr. Travers thinks it more reasonable to conclude that a great elevation of the South Island above its present level would give a climate sufficiently cold. An elevation of the South Island of about 4000 or 5000 feet would, in Mr. Travers' opinion, give a climate quite as cold as that assumed for the glacial epoch.

The exigencies of these theories require either a change of climate to something like the cold of Greenland, which would satisfy Dr. Haast's requirements, or a great elevation of the land. Of course, when we use imagination in scientific matters we have sometimes to draw liberally on nature for support; and Mr. Travers' theory has an elasticity about it, for, if we object to an elevation of 5000 feet as insufficient, we might double the elevation without being unreasonable.

The strength of Captain Hutton's views springs out of the fact that he

summons to his aid the great leveller and engineer—the sea, with its never-ceasing waves grinding the rocks into sand, and fashioning the boulders, and assorting the materials brought to it, either by the glaciers themselves or by the rivers flowing from the mountain ranges, and spreading them out in vast plains. Everything seems to show that plains of any extent are the result of the action of the ocean, or of vast inland seas. I do not question the statement that terminal moraines attain great size, and form mounds of rough angular fragments and débris—perhaps some hundreds of feet in height. These are the wastes of the mountains. What I contend for is, that nowhere is this confused débris scattered far and wide and levelled out into strata, forming plains of great extent by the action of glaciers. Captain Hutton admits that the glaciers of the South Island have been at some former time of much larger dimensions than they are at present, and that there may have been a glacial epoch in the southern hemisphere. But he does not admit that such an epoch bears any relation to, or was contemporaneous with, that of Europe. He would refer it, if it ever existed at all, to a period long antecedent. At the same time he guards himself by stating that we have no proof of a change of climate; and, as he considers an elevation of the land of about 3000 feet would be able by itself to account for a great extension of the glacier system, there is no necessity of calling in the aid of any other cause.

The existence of a glacial epoch must not be denied here. It is a settled question among geologists that many of the changes on the earth's surface are due to it. If I am not encroaching too much on your patience, I will explain why I do not think we are justified in objecting to Dr. Haast's assumption of a glacial epoch in the southern hemisphere on the ground that it is of a very remarkable character, and as being supported by no evidence whatever; at any rate he follows in the wake of great men. We find Professor Agassiz startling the geological world by his strong opinion that a gigantic glacier once filled the entire valley of the Amazon, and he invited the members of the Alpine Club to go out and search for traces of glacial action on the mountains of Ceaná; and I see by a notice in "Science Gossip" that on his South American Expedition he discovered evidences of glacial action on a scale so extensive as to more than suggest that the southern hemisphere has undergone a similar general glaciation to that of the northern. The glaciation has been traced as far as the northern end of Chiloe Island. The Professor believes that during the glacial period the two hemispheres were capped with a sheet of ice of enormous thickness. Ancient moraines abound in South American valleys; and in the Straits of Magellan one was found damming up a valley.

But, as I said before, we must not overstate the action of ancient glaciers. I see that Dr. Hector, in his address last year, states that the mountain ice-cap

performs its work of eroding the elevated rock mass into ridges and peaks; and that after the first rough excavation has been performed, and only the hard cores of crystalline or tough metamorphic rocks have survived the denudation, and when the valleys have all been perfectly moulded to perform their functions of ice gutters, then the process is admitted to be very slow. But to ascribe thus to glacier action the formation of the very ridges and peaks of mountain tops is, I think, unreasonable. In fact no larger amount of work can be assigned to glaciers even of the glacial epoch, as the Duke of Argyle remarks in a quotation made by Mr. Travers, than that of deepening the valleys which existed before—that on the one hand when the period began it found the existing system of hills and valleys in the main determined, and on the other that it cannot have left them exactly as it found them. But this is very far from the view which Dr. Hector would seem to maintain—that mountain and valley, with all their characteristic variety of surface, have been cut out of the solid by enormous glaciers. Now, the very opposite is the case. It is the pre-existing configuration of hill and valley and mountain range which has determined the movements of these glaciers, so that, as the Duke of Argyle says, the effects of glacial denudation become a comparatively narrow question.

But whether we ascribe too much or too little to the existence of a glacial epoch, let us for a moment consider what are the probable causes which might explain the extraordinary changes of climate which have certainly existed in the earth in very distant epochs of time.

There are two sources of heat which have varied greatly—the heat of the sun and heat from the body of the earth itself.

Our faculties can form no conception, and can make no answer to the question, how far the forces which are in activity in the sun have exhausted themselves. Say that such changes can be worked out in any length of time that can be assigned; such period, however vast, is nothing to eternity. To eternity no limit is assignable; priest and philosopher alike are ignorant here. But though we can give no answer to the question, we are assured that the forces which are in activity in the sun as revealed to us by light, "the winged messenger," through the spectroscope, are forces operating on the same substances as those which form the earth; that they must have had a beginning, as assuredly they will have an end; and that the sun will in the course of time cease to evolve heat, light, and electricity. It seems certain that they vary greatly in their intensity—at one epoch the heat of the sun may have been much greater than it is now, and at another far less. It is impossible they can have always been the same.

I have dwelt longer on this subject than I should have done, had I not been desirous of introducing to your notice the very plausible theory of

Mr. Croll—a theory rendered more interesting because Darwin has used it to explain facts in connection with the distribution of plants and animals, and because it involves the admission that a glacial period existed in the southern hemisphere, but at a period of about 13,000 years, or some multiple of that time, prior to the northern epoch. This, again, is in support of Captain Hutton's views, who, with his usual caution, states that if he were to adopt the opinion that a glacial epoch once existed in the southern hemisphere, it would be with the distinct understanding that it was far anterior to the pleistocene period—that is, anterior to the northern epoch.

In giving you an epitome of Croll's views, I shall, with slight exceptions, use his own words.

Croll's theory is based on the assumption that during the glacial period the eccentricity of the Earth's orbit was at least double what exists at present, but not so great by far as the eccentricity of the orbit of the planet Mars. This supposition does not involve any increase in the mean distance of the Earth from the Sun, nor in the period of revolution—both of these elements of our orbit are absolutely unchangeable.

The first step in Croll's argument is that ocean currents are produced by winds; that the main ocean currents agree with the direction of the prevailing winds, as may at once be seen by comparing the direction and paths of the prevailing winds, shown in Messrs. Johnston's small Physical Atlas, with the ocean currents as shown in the Current Chart published by the Admiralty. Of course the conformation of sea and land partially interferes with this agreement, but the principal currents of air and of water agree precisely. There is nothing new or extravagant in this. The younger Herschell vindicates to the winds their supremacy in the production of ocean currents. If, says Herschell, there were no wind there would be no Gulf Stream, or any other considerable oceanic current.

Croll next shows that oceanic currents are the great distributors of heat over the globe. Taking for instance the Gulf Stream, he calculates the amount of heat conveyed as so enormous as to be equal to one-fourth of all the heat received from the sun by the Atlantic Ocean from the Tropic of Cancer up to the Arctic Circle; and were it not for the Gulf Stream, and other ocean currents, only a small portion of the globe would be suited to the present order of sentient beings; that London, instead of possessing a mean annual temperature of nearly 50°, would have a mean temperature of not over 10°. Of this enormous amount of heat one-half is derived from the southern hemisphere by means of ocean currents. Without such transference of heat it would be impossible to account for the North Atlantic being 5° warmer than the South Atlantic. *This current from the south is owing to the superior strength of the S.E. trades.*

We thus see that Croll's argument is based on two facts, which he considers placed beyond all doubt—that winds are the impelling cause of ocean currents, and that the ocean currents are the great agents employed in distributing over the globe the excess of heat received by the sea in intertropical regions.

The majestic flow of waters from the Gulf of Mexico—that "mighty river," as Maury terms it—equals in magnitude a current of at least forty miles broad and 1000 feet deep, flowing at the rate of two miles an hour, and conveys a quantity of heat equal—to use the philosophic slang of the day—to 77,479,650,000,000,000,000 foot-pounds. That he has not overestimated either the temperature or the volume of the Gulf Stream is shown by the important results obtained during the "Challenger" expedition. Between Bermuda and Sandy Hook the stream is sixty miles broad and 600 feet deep, with a maximum velocity of from three and a half to four miles an hour; while the observations made between St. Thomas and Sandy Hook reveal the existence of an immense flow of warm water 2300 feet deep, coming either from the Gulf of Mexico or from the Caribbean Sea. At Sandy Hook it extends 1200 feet deeper than the Gulf Stream itself. This mass of water, after travelling northwards for about 1000 miles, crosses the Atlantic in the direction of the Azores, where it appears to thin out.

Croll then goes on to argue that any cause which will greatly affect the currents, or greatly change their paths and mode of distribution, will of necessity greatly affect the climatic condition of the globe. But, as the existence of these currents depends on the winds, any cause which will greatly affect the winds will also greatly affect the currents, and consequently will influence the climatic conditions of the globe. Again, as the existence of the winds depends mainly on the difference of temperature between equatorial and polar regions, any cause which will greatly affect this difference of temperature will likewise greatly affect the winds. That is, should any cause increase the difference of temperature between the equator and the pole on the one hemisphere, and decrease that difference on the other hemisphere, it would effect a change in the *distribution* of the aerial currents, which change would in turn produce a corresponding change in the distribution of ocean currents.

Now, an increase in the eccentricity of the earth's orbit tends to lower the temperature of one hemisphere and to raise the temperature of the other. Let us imagine the eccentricity at its superior limit to be ·07775, and the winter solstice of the northern hemisphere, instead of *in perihelio* as at present, to be *in aphelio*. The midwinter temperature, owing to the increased distance of the sun, would be lowered enormously; and the effect of this would be to cause all the moisture which now falls as rain during winter in temperate

regions to fall as snow. Nor is this all; the winters would not merely be colder than now, but they would be also much longer. At present the summer half-year in the northern hemisphere exceeds the winter half-year by nearly eight days; but at the period in question, supposing the eccentricity of the earth's orbit increased, the winters would be longer than the summers by upwards of thirty-six days. The heat of the sun during the short summer would not be sufficient to melt the snow of winter, so that gradually year by year the snow would continue to accumulate on the ground. At the same time it is quite true that an increase of eccentricity does not give more solar heat to the one hemisphere than to the other, but, nevertheless, it would bring about a different state of things.

On the southern hemisphere the opposite condition of things would obtain. Owing to the nearness of the sun during the winter of that hemisphere, the moisture of the air would be precipitated as rains in regions where at present it falls as snow. This and the shortness of the winter would tend to produce a decrease in the quantity of snow. Thus you will observe that the difference of temperature between the temperate and polar regions would be greater on the northern than on the southern hemisphere, and as a consequence the aerial currents of the northern hemisphere would be stronger than those of the latter. This would be more especially the case with the trade winds. The N.E. trade winds, being stronger than the S.E. trades, would blow across the equator, and thus the equatorial waters, driven by the winds, would be impelled more to the southern than to the northern hemisphere, and the warm water carried over to the southern hemisphere would tend to increase the difference of temperature between the two hemispheres. And it was this mutual reaction of those physical agents which led to that extraordinary condition of climate in the northern hemisphere which prevailed during the glacial epoch.

At present the S.E. trades are the stronger, and sometimes extend to 10° or 15° north of the equator; so that the mean position of the median line lies at least 6° or 7° north. But if Croll's views be adopted, the N.E. trades blowing across the equator, the median line would be shifted considerably to the south of the equator. The effect of this shifting the median line between the N.E. and the S.E. trades from the northern to the southern side of the equator, and with it the equatorial current of the Atlantic, would be that the whole of the waters would strike obliquely against the Brazilian coast, and thus be deflected into the Southern Ocean. The effect produced on the climate of the North Atlantic and North-Western Europe by the withdrawal of the water forming the Gulf Stream may be conceived from what has already been stated concerning the amount of heat conveyed by that stream. The heat thus withdrawn from the North Atlantic would go to raise the

temperature of the Southern Ocean and Antarctic regions, and a similar result would take place in the Pacific Ocean.

In the regular course of events the long axis of the earth's orbit would shift, and in about 12,934 years the winter solstice of the southern hemisphere would be in the aphelion, and in New Zealand the glacial epoch would be at its maximum, while in the northern hemisphere the great Gulf Stream, together with the flow of southern waters across the equator, would be greatly increased, and even the coast of Greenland would enjoy a warm and equable climate; and such a temperate climate must once have ruled in Greenland. Professor Heer has concluded from his examination of the fossil flora that the temperature of Greenland was about 30° higher than it is now. You will find from Professor Heer's "Contributions to the Fossil Flora of North Greenland" much wonderfully calculated to revolutionize our notions of the climate of the north of Europe. In the deposits of the outskirting land under the great ice-field which now obliterates all indications of hill and valley were found "thirty different kinds of cone-bearing trees, including species allied to the gigantic *Wellingtonia*, at present growing in California, with other trees, such as beeches, oaks, planes, poplars, maples, walnuts, limes, a magnolia, hazel, blackthorn, holly, logwood, and hawthorn. These were represented not merely by leaves, which occurred, however, in vast profusion, but by fossil flowers and fruits, including even cones of the magnolia, thus proving," says a writer in the "Popular Review," "that they did not maintain a precarious existence, but ripened their fruits. Vines twined round their trunks—beneath them grew ferns having broad fronds, and with them were mingled several evergreen shrubs." These deposits belong to the miocene age.

I wish to dwell on this because it has a meaning which must not escape us. In latitudes so high as those of Greenland, no hypothesis, based on an assumed elevation or depression of land, will account for the warm climate which must have existed in Greenland in times remotely ancient. We might look to changes in the great luminary whose rays vivify either directly or indirectly all growth on earth. But additional light is thrown on this subject if we accept Croll's hypothesis. During the glacial period in the south, the medial line of the trades may have been shifted some 20° to the north. Under such a condition of things, says Croll, the warmest part would probably be somewhere about the tropic of the warm hemisphere, and not, as now, at the equator; for since all, or nearly all, the surface water of the equator would then be impelled over to the warmer hemisphere of the north, the tropical regions of that hemisphere would be receiving nearly double their present amount of warm water, and Greenland would enjoy a temperature at least 30° degrees higher than at present. And when the snow accumulated in the southern hemisphere, and attained its maximum, we should have the

glacial epoch of Dr. Haast, with its enormous glaciers creeping into the plains.

The fossil flora of Greenland is the circumstantial evidence of strange physical changes. To my mind it has a romantic interest, and must surely influence us all in our conceptions of the past history of the world we inhabit. Although these discoveries do not point to any wild convulsions of nature, there are other evidences of startling antiquity that certainly prove that stupendous forces were once in activity.

As respects the sun, there must have been in the past, and there will be in the future, great variations in the intensity of the forces in operation. Even in our short lives one summer's heat varies with another, and it may be said with almost absolute assurance that in far off ages of the solar system the heat radiated from the surface of our great luminary may have been less than at present, and, rejecting Croll's theory, you may ascribe the origin of the glacial epoch to a large diminution of the radiant heat of the sun.

The highest manifestation of intellect is that mental progression, which, passing step by step in its accurate review of nature, seeks resemblances, and for what, in the nomenclature of mathematics, is termed "the continuity of phenomena,"—never flying "far and wide" of its mark,—but with unyielding tenacity cautiously seeks in the sun and the planets for the same relation of things which are found in the globe we inhabit. It seems to me that the first great step made in our knowledge of the sun was that important law which Spencer sought to establish, that the sun matter must conform to the same laws which govern matter here. Nothing can be more interesting than Spencer's remarks on the physical constitution of the sun, and I cannot understand why a higher value has not attached to the profound thought and far-seeing ponderings of this truly capacious intellect. All the credit is given to those who have marvellously verified Spencer's ideas by direct observation with the spectroscope.

It may be well, writes Spencer so far back as the year 1858, to consider what is the probable condition of the sun's surface. Round the globe of incandescent molten substances forming the visible body of the sun there probably exists a stratum of dense aeriform matter made up of sublimed metals and metallic compounds, and above this a stratum of comparatively rare medium analogous to air.

How superior these propositions appear to the fanciful notions of late astronomers, who fluttered around their far-fetched notions, and fancied, because they coined new words, that they were in progress.

The governing idea which animates the present age, the grand field of modern generalization, is the universal acceptance of the law that the same matter, ruled by the same laws, exists within the sun, the stars, and the

world we inhabit; and the grand conception is that the earth, the planets, and the sun, are all under a law of transition. This is the *lumen siccum* which is diffusing its rays all around—developing the most astonishing revolutions in natural philosophy. Well may men like Tyndall and Spencer rejoice in lofty labours.

The heat on the sun's surface is so intense that the elements of compound bodies are torn apart by its destructive energy. The chemical union between oxygen with iron, magnesium, calcium, etc., is over-mastered. Both gas and sublimed metal rise into the higher regions of the sun's atmosphere; the metals carry with them in their vapourous state enormous supplies of latent heat, absorbed from the molten surface of the sun. In the higher and less heated regions of the sun's photosphere the atoms of oxygen and metals are again brought within the powers of chemical forces, and by their mutual attraction clash together in fixed proportions, forming there the incandescent willow-leaf forms of Nasmyth. These, in their condensed form, dart into space heat, light, and electricity; their latent heat becomes sensible; and they sink again to the surface of the sun, again to gather up fresh stores of heat and light, again to rise up to the upper regions of the sun's photosphere, to be there again subject to the forces of chemical affinity, and in their hot conflict to be the immediate source of radiant heat and light, and so on through countless cycles, radiating into stellar space the sun's almost exhaustless supplies of heat, light, and electricity.

The younger Herschell speaks of these feculæ, or willow-leaf forms, almost with an abuse of the imagination, as amazing organisms partaking of the nature of life, each not less than 1000 miles in length, whose fiery constitution, as Proctor remarks, "enables them to illume, warm, and electrify the whole solar system. Truly Milton's picture of him who in the fires of hell lay floating many a rood, seems tame and commonplace compared with Herschell's conception of these floating monsters."

These marvellous displays of chemical forces cannot possibly have been equally intense in all ages, and there is a possibility that the glacial epoch was the result of diminished intensity of the forces in operation in the sun.

Next, as to the heat from the body of the earth itself. I have not without a purpose alluded to the astounding fact made known by the spectroscope, that the sun is composed of the same substances as those which form the earth. And I now wish you to admit the probability that those forces which are in activity in the sun were once in a like activity in the planets, our earth, and the moon; and that our earth is in an intermediate stage between that of the sun on the one hand, and the moon on the other. In the moon the chemical forces are exhausted. Every change arising out of chemical combinations is completed, and with that completion all further display of heat

and light. In the sun, on the other hand, from the greater length of time necessary to complete the cycle of chemical transformation in so enormous an orb of matter, chemical union is momentarily taking place, to be again torn asunder, as revealed to us by his heat and light. It is a barren philosophy which leads us to ignore the forces we daily witness on the globe we inhabit. The grand force in operation around us is chemical affinity—it has wrought all the grand phenomena of nature; everywhere are seen its gigantic structures—the crust of the earth—the waters on its surface—everything we touch—life itself is the creation of this marvellous force. The mild anti-paroxysmatism of Hutton and others is being broken down. Lime, magnesian rocks, clays, etc., which form the crust of the earth, are definite compounds of oxygen with the respective metals, calcium, magnesium, and aluminium. These elements must once have been separate, and their union must have been accompanied by the same enormous display of heat and light, of which we have now an example in the mighty chemical actions in activity in the sun. And there remain unquestionable proofs of past high temperature in the rate at which the temperature increases on descending below the earth's surface.

There is every reason to believe that the condition of things which probably exists in the planet Jupiter was for ages the fixed condition of our globe. Proctor expresses his firm belief that no one can study that planet for many hours without becoming convinced that the cloud masses which envelope his disk have a depth of at least one hundred miles, and he goes on to show that the pressure of such a depth of atmosphere would be so enormous that the lower stratum could not possibly exist in a gaseous state except at an enormously high temperature, and thus we are driven to the conclusion (to use Proctor's words) that "Jupiter is an orb instinct with fiery energy—aglow it may well be with an intense light which is only prevented from manifesting itself by the cloudy envelope which enshrouds it." The same envelope which prevents the passage of light hinders also the loss of heat from the body of the planet.

These views are strengthened, adds Proctor, by the remarkable phenomenon that for three or four years Jupiter's mid-zone has been aglow with a peculiar ruddy light, but has lately returned to the ordinary creamy white colour. This change of colour was probably owing to some great commotion in the glowing mass beneath making itself manifest by its greater energy through the vast depths of his cloudy envelope.

There must have been a time when the heat of the ocean and of the surface of the earth were retained by a similar deep envelope of clouds, followed by a less heated state of the globe, when plants, of whose profusion and rapid growth we can scarcely form a conception, might have enjoyed the combined heat of the globe and the radiant heat of the sun.

At the conclusion of the address, a vote of thanks was moved by Mr. W. T. L. Travers, seconded by Mr. J. C. Crawford, and carried, both these gentlemen, however, pointing out those portions of the address to which they took exception.

Dr. Hector introduced to the notice of the society a very important question as affecting the interests of sheep farmers and agriculturists throughout the colony, namely, the presence of Ergot in rye grass. The subject was one to which Dr. Hector had devoted some attention previously, but the presence of Ergot in rye grass pastures had so much increased during the past season that several persons residing in various parts of the colony had brought the subject again under his notice by correspondence, which was read to the meeting. From this correspondence it appeared that the Hon. Mr. Fox had devoted considerable attention to the subject, and his experience, together with that of the other communicants, went to show that the effect of the presence of Ergot was to give rise to a disease amongst breeding stock, which greatly reduced the increase. In one instance quoted, where a flock of ewes had been placed in a paddock where Ergot was afterwards found to be present, the increase was only seventeen per cent. Cattle and horses were said to be affected by the Ergot in the same manner. Dr. Hector said the subject was one which required close investigation, as it was quite possible that the same unseasonable weather which favoured the growth of fungi might also produce the effects attributed to the presence of Ergot. It was undoubted, however, that some of the symptoms described in the correspondence were such as would be produced by ergotism. He had placed the specimens in Dr. Berggren's hands for examination, and it might be regarded as very fortunate that there was at that moment, during the discussion of so important a subject, such a high authority amongst them.

Dr. Berggren, being requested to assist the society in its investigations, proceeded to give a clear and interesting statement of the growth and development of the Ergot, which he described as a fungus that passed through three distinct stages of existence : first, attacking the flower of the plant affected by it ; next, the seed, in which condition it developed the characteristic spur or horn by which it is distinguished from other diseased grain, such as rust and smut ; after which it fell to the ground and developed different spores, from which sprang a ground fungus of a red colour shaped somewhat like a mushroom, the spores shed from this latter form being those which attack the flower of the grass. The specimens submitted to him were unmistakably the true Ergot, which he thought must have been introduced into the colony with grain. He said it was quite possible the mild winters of New Zealand might affect its mode of development, as it might not require to remain so long in its winter state as in the north of Europe.

Mr. Travers thought it important that some remedy should be sought for at the earliest possible moment.

Dr. Berggren explained that the most speedy manner of eradicating the Ergot seemed to be to prevent the grass from seeding by cutting it before the seed ripened and then burning it.

The Hon. Mr. Fox inquired whether it was possible that the pasture would be affected by having had Ergot on it at seeding time, to such an extent as to poison stock feeding upon it afterwards. This he considered as the most important point for the practical farmer to consider, as the stock could be kept off the grass while it was actually in ear.

Mr. C. O'Neill asked what effect frost, snow, and severe weather would have upon the Ergot.

Dr. Berggren replied that the seed of grain affected with fungus was usually steeped in sulphate of copper, but that process was efficacious only when the seed itself carried the germ; it would be of no use when the fungus spores first attacked the plant when flowering. He did not think pasture became affected so as to be poisonous after the flowering season was past. In reference to Mr. O'Neill's question, Dr. Berggren said that of course climate might affect the Ergot, but he was not aware whether in this country there were places where the rye grass flowered while frost and snow were on the ground.

Mr. C. C. Graham said that four years ago he remarked the presence of Ergot, or something like it, in the toitoi grass at Rangitikei during a cold, wet season like the present. The Ergot was evidently widely spread this year, as he had received specimens of it from a correspondent at Timaru, which were amongst those examined by Dr. Berggren.

The Hon. Mr. Fox felt satisfied that wet was not the cause of Ergot, as the specimens he sent to Dr. Hector were cut during one of the driest seasons known in his district.

The Hon. Mr. Randall Johnson expressed himself as greatly interested in the matter, as some of the symptoms described were of frequent occurrence amongst the stock at Poverty Bay, and he had never been able to obtain any satisfactory explanation as to the cause. What he had heard that evening was very suggestive. The disease, whatever might be its nature, was curable only by change of pasture. It affected horses in his district, though it was rarely fatal in such cases. In one fatal case an examination showed the spinal cord of the horse to be in a diseased state.

Dr. Hector expressed a hope that the subject would receive the attention of farmers and others who were directly interested, as they had the best opportunities for observation. It seemed clear that the subject was not well understood at present.

The President stated that there were yet thirteen papers on the list for that evening, but, as the important discussion just concluded had occupied so much time, they would, of course, have to be delayed. The number of papers on the list showed the growing interest in the proceedings of the society, and it would probably suggest itself to members that they should meet more frequently than usual.

SECOND MEETING. *25th July*, 1874.

Charles Knight, F.R.C.S., President, in the chair.

New members.—Edward Osborne Gibbes, Thomas E. Young, A. J. Woodhouse (London), Captain Gudgeon.

A number of valuable presentations were on the table, among them a magnificent folio volume of the Flora of Central Africa, presented by J. A. Tinne, Esq., of Ayburth, near Liverpool.

1. Dr. Hector drew attention to the articles with which the Museum had been enriched by the "Challenger" expedition. These consisted of specimens of different fishes, etc. The first was that of a large fish—the *Ceratodus fosteri*, Krefft, or Barramunda, of the Queensland rivers, of which Dr. Hector gave the following account :—

The fish to which I have now to draw your attention is one of the most interesting additions that has been made within modern times to this branch of zoological science. The first specimen was discovered in the beginning of 1870 in the north of Queensland, where it is known by the native name of the "Barramunda." It appears not to be uncommon, as specimens have been obtained in several of the rivers, not only in the upper parts where the water is quite fresh, but also near the sea where it is brackish. It is a vegetable feeder, living on decaying leaves of gum trees and other myrtaceous plants, and yet, strangely enough, its flesh is described as excellent eating and resembling salmon. The chief interest attaching to this fish arises from the circumstance that it is the living representative of an intermediate class of amphibious animals from which in early times sprung fishes on the one hand, and true reptiles on the other. Unlike any other fish, it has a lung, but has also gills, thus possessing two distinct modes of purifying and oxygenating its blood.

We know that this is the embryonic condition of the lower forms of reptiles, and the persistence of this double breathing apparatus is probably suited to the condition under which this curious animal exists.

Thus Dr. Günther describes* that whilst Barramunda is in water suffi-

* A memoir of the entire organization of this interesting fish was presented to the Royal Society by Dr. Albert Günther, F.R.S., of which a short résumé will be found at page 222 of the Ann. and Mag. N. H. for March, 1871.

ciently pure to yield the necessary supply of oxygen, the function of breathing rests with the gills alone; but when the fish is compelled to sojourn in thick muddy water charged with noxious gases, which must be the case very frequently during the droughts which annually exhaust the creeks of tropical Australia, it commences to breathe air by its lung direct from the atmosphere, rising to the surface of the water from time to time for this purpose.

The skeleton of the Barramunda, and the construction of its heart, require it to be placed, as Dr. Günther has shown, among the ganoid fishes—a section of the cartilaginous fishes that was largely developed in early geological times. Notwithstanding its large size and well-developed fins, its internal skeleton is only represented by a long, tapering, cartilaginous cord, without distinct vertebræ, and with only a simple capsule for a brain case. The appendages of this central structure are, however, encased in a thin crust of bone, so that the ribs and processes for the attachment of the limbs, and the jaws for the attachment of the teeth, are slightly rigid.

The limbs are two pairs of paddles, very similar to each other in shape, and very unlike the ordinary fins of fishes, resembling more the appearance of the paddles of an *Ichthyosaurus.* The teeth of the Barramunda consist of hard plates, four above and two beneath, and they afford the chief point of interest which this remarkable fish possesses for the palæontologist, as they exactly resemble the fossil teeth described under the name of *Ceratodus.* It is now easily understood why nothing but the teeth and the ganoid scales ot the extinct fish should have been preserved. A few specimens of the Barramunda were obtained by Professor Wyville Thomson on his recent visit to Queensland, while H.M.S. "Challenger" was in Sydney, and among them this specimen, which he brought specially for this Museum, being one of the most important of the many contributions we received from the "Challenger" expedition.

The "Challenger," after leaving the Cape of Good Hope, went as far south as 67°, close to the ice barrier, and visited Kerguelen Land, where some interesting photographic views that were exhibited had been taken. An interesting point, illustrated by microscopic specimens on the table, is that at a depth of 2600 fathoms, close to the ice, the sea-bottom is composed of siliceous Diatoms, while in the same depth further north the deposit is formed of calcareous Foraminifera. The latter appear to have been dissolved in the cold polar under-current, so that when they are reached in the deep soundings in more temperate latitudes only a fine mud is found, composed of the small percentage of insoluble matter which the calcareous skeletons contain. In taking soundings for the telegraph cable line, the "Challenger" ran a straight course from Sydney to Cook Strait. On leaving the Australian coast the soundings showed a gentle gradient to the great depth of 2600 fathoms, which,

with only one shoal, was carried to within a few hundred miles of our coast, when the soundings rather suddenly decreased from 15,000 to 4000 feet. This submarine precipice lies about 300 miles from land opposite Cape Farewell, but there is reason to believe that further south it approaches the coast, and at Milford Sound is close to the shore. On this plateau the dredge was used, and some interesting specimens were obtained. Of these, several new species of fish had been handed to Dr. Hector for description. These were exhibited, and their characters described at length. They comprised, among others, *Trachichthys intermedius*, *Scorpæna barathri*, *Platystethus abbreviatus*, *Macrurus armatus*, *Pseudorhombus boops*, and some others. Dr. Hector, also, in passing described several other new fish. Among them were *Plectropoma huntii*, from the Chatham Islands; *Maurolicus borealis*, from Preservation Inlet, a former specimen of which had been obtained in Milford Sound in 1863; and *Leptoscopus robsoni*, from Cape Campbell. (*Transactions*, p. 245.)

He also showed two fine specimens of the New Zealand avocet, a bird with a very remarkable upturned bill, and a specimen of *Procellaria lessoni*, a sea bird, of which only one specimen appears to have been hitherto obtained in New Zealand.

With regard to the *Ceratodus*, Mr. Hood mentioned that it is confined, so far as we know, to the Dawson and other tributaries of the Fitzroy, an eastern water of Queensland. The dividing ridge between them and the head waters of the Darling is of small elevation and very narrow, but it is not known in that river. It had for years been used and esteemed a delicacy by the settlers, who gave it the name of the Dawson Salmon, its flesh resembling that of the salmon in colour; and it might still have remained unnoticed had it not attracted the attention of his friend Mr. Foster, late Premier of New South Wales, when he happened to visit that district.

2. "Did the great Cook Strait River flow to the North-West or to the South-East?" by J. C. Crawford, F.G.S. (*Transactions*, p. 448.)

The Hon. Mr. Mantell spoke against the theory propounded by Mr. Crawford, and Dr. Hector agreed with Mr. Mantell, yet the latter thought that there was evidence to show that New Zealand had altered very much.

3. "Observations regarding the Hot Winds of Canterbury and Hawke Bay," by T. H. Cockburn-Hood, F.G.S. (*Transactions*, p. 107.)

This paper gave rise to an animated discussion, in which many members took part. Mr. Waterhouse, Mr. Webb, M.H.R., and Captain Fraser did not think that the hot winds in New Zealand had any connection with those in Australia.

THIRD MEETING. *8th August*, 1874.

Charles Knight, F.R.C.S., President, in the chair.

New members.—Andrew Tod, J. E. Nathan, Hon. Colonel Brett.

Dr. Hector called attention to the valuable contributions which had been presented to the Museum since the last meeting. Among these were a large collection of *Crustacea*—shrimps, prawns, and such like—found at Spitzbergen, presented, with some valuable works, descriptive of the collection, by Professor Lovèn, of Stockholm; also a series of English Crag fossils, presented by Mr. Crowfoot, of Norwich.

1. "Description of a Wreck found at the Haast River," by Thomas Turnbull, Harbour-master at Hokitika; communicated by W. T. L. Travers, F.L.S. (*Transactions*, p. 146.)

This fragment was found at a great distance from the present high-water mark, surrounded by dense bush. It was discovered by diggers in 1867, since which time no trace could be found of any vessel of that class having been wrecked on the coast of New Zealand. From the peculiar manner of construction, Captain Turnbull concluded that it was a piece of the hull of a French or Netherlands built ship.

Dr. Hector said that in 1867 he had called attention to the wreck in a short account which appeared in the society's papers, and, by the kindness of the District Surveyor, Mr. Muller, he had been enabled to make the sketch showing the position of the wreck, which he exhibited. The most important point was the distance from high-water mark at which it had been found, which was fully 300 yards. It was surrounded by low ngaio scrub, the terraces behind being heavily timbered. This proved that the high-water mark at that time must have been very different from what it is at present. It had been suggested during the former discussion that the piece of wreck had been cast into that position by an earthquake wave, but he thought it rather due to the rapid making of the coast. The vessel to which it had belonged had been built in a peculiar manner, screw trenails having been used, and a layer of felt between every two layers of timber.

The Hon. Captain Fraser suggested that it might be a portion of La Perouse's ship "l'Astrolabe," which had for many years been sought in vain. He intended taking a portion of it home with him, and lodging it with the French Government, with a view to identification.

2. "On the Identity of the Moa-hunters with the present Maori Race," by Alexander McKay, of the Geological Survey Department. (*Transactions*, p. 98.)

Mr. T. Cockburn-Hood said, with reference to the existence of distinct traditions regarding the Moa, few persons could possibly doubt the fact who

were aware that in 1837, before any of the present settlements in New Zealand were occupied by Europeans, a writer on these islands, Mr. Polack* had stated his conclusion from the stories he heard from the natives, that a large struthious bird existed still in Victoria, as he called the South Island, and was only lately extinct in the Northern. He had received a very interesting letter from the highest authority and ablest writer on old New Zealand, Mr. Maning, Judge of the Native Lands Court, and, although he had not his permission to do so, would venture to read from it some extracts which would satisfy all who heard them, beyond the shadow of a doubt, that the Maori knew the Moa perfectly well:—

"There is no subject, except perhaps the history of their wars and migrations, none on which the traditions of the Maori are so numerous and particular, as those regarding the Moa—none which have that freshness and vraisemblance which are perfectly convincing to those who know them: indeed, the natives would be much amused if any pakeha from Europe should set to work to persuade them that their forefathers had not hunted the Moa, and at no remote date.

"The natives are particularly remarkable as acute observers of everything coming under their notice; they have named every tree, shrub, plant, and insect in the country, and, what is more remarkable, have classified the plants to a great extent, and upon very sound principles.

"The Moa was of such incalculable value to them as animal food that to facilitate its capture they have evidently, as in the case of smaller birds used for food, studied with the greatest keenness its habits, food, character, and everything possible to be known about it. Their songs contain allusions to hunting the Moa, and tradition tells how they caught, cooked, the fat melted, and preserved, and in fact everything about them.

"The Moa appears to have been a stupid, inert bird, except at certain seasons, when it is supposed they came together and fought with great obstinacy, when many were killed. There is a Maori saying which is parallel to our "stupid as a goose"; they sometimes say of a man, "he is as inert as a Moa." I have no doubt whatever, and Maori tradition affirms positively, that the extinction of the Moa was accomplished by their wasteful method of hunting.

"The traditions of the great bird of prey are fully as explicit and particular as are to be expected. * * That it was called in song, 'Hokioi of the resounding wing'; that it inhabited the mountain peaks; that its appearance, under certain circumstances, was considered ominous; that it came often accompanied by thunder and lightning, probably driven to the low grounds by the storm, and, where I now sit writing, I can see a tract of land which has

* See Trans. N. Z. Inst., V., p. 413.

been for many generations called 'The wing of the Hokioi,' from the tradition of the appearance of the great bird at that place. When the Moa became extinct the destroyer died also, having nothing left to feed on, and so both these great creatures have disappeared, to be seen no more."

Judge Maning also bears indisputable testimony to the assertion that the flint and obsidian flakes found about the Moa-hunters' ovens and kitchen middens cannot be considered as the slightest evidence of the existence of an inferior race of men by whom these birds were exterminated.

"Those flint flakes and obsidian splinters certainly have been used by all aboriginal races all over the world; but Dr. Haast says that the people who used the greenstone, well-finished tools, were a different people from those who used the flint flakes. This is absolutely not the case, for I have seen the obsidian and flint flakes in full use myself; have seen the splinters knocked off the blocks of obsidian; the blocks were an article of traffic, and kept with great care, and splinters knocked off (it required some art to do it properly) as they were wanted from time to time. These splinters were the ordinary kitchen knives, so to speak; they were also used for cutting hair, cutting up human bodies, for surgical instruments, for cutting flax and raupo.

"The obsidian broke off with an extremely fine edge, but it would not last, and was quite useless for cutting wood, making paddles, canoes, or clubs—the greenstone was used for these purposes, and the tools made of it were valued far more than an equal bulk of gold ever was in the civilised world."

Mr. Travers regretted that he had not been aware that the paper on the Sumner Cave was to be read that evening, as he had in his possession a quantity of bones and implements dug out of that cave, and along with them the fragment of a gourd which had evidently been used for drinking purposes. He might mention, as an interesting fact, that there was a family of Maoris who frequently, for months at a time, occupy a cave in Port Nicholson under exactly similar circumstances to the early Maori inhabitants of the Sumner Cave. This cave is situate at less than a mile from the pilot station at the Heads. There were six or seven Maoris living there, and he had frequently visited them. They live chiefly on shell-fish.

Mr. Webb remarked that a complete human skeleton, now in the Christchurch Museum, had been found in the cave, no mention of which was made in Mr. McKay's paper. He also stated that a fine deposit of Moa bones had been lately found in the silt deposit that covers the hills round Lyttelton harbour.

Dr. Hector said that the only grounds Mr. McKay had for doubt as to the recent date of the Moa's existence seemed to be the absence of Maori traditions with regard to it. He could only say that modern Maoris seem to know all about it. When he was at Hikurangi he sought out the oldest Maori, and

conversed with him respecting the different kinds of birds there. The Maori knew the Moa, and said he could get some of the bones, and that he knew a man who had seen one. He also knew the tarepo, which was a kind of large goose that went about with the Moas. They were now extinct, but had been seen by living Maoris. We should bear in mind that if Mr. Mantell had not procured two skins of the *Notornis*, they would have known of its existence only from bones found in Maori ovens, as in the case of the Moa. On the whole he thought there was no reason for jumping to the conclusion that the Moa had become extinct at a very remote period. The positive evidence of the existence of the Moa in New Zealand was probably greater than that of the existence of the emu in some parts of Victoria. Many persons were not conversant with the rapidity with which animals disappear. In proof of this he would refer to the bison. A hundred and fifty years ago these animals roamed over the Eastern States in countless herds; yet it would now be very difficult to obtain positive proof of their existence in those States. We should, therefore, be careful in accepting assumptions on this subject, as they might mislead us in regard to the physical changes in post-tertiary times in New Zealand, and especially as there is no country so favourably circumstanced as this for settling interesting questions about the origin and variation of species and other important points.

3. "Notes on Maori Traditions of the Moa," by J. W. Hamilton; communicated by Dr. Hector. (*Transactions*, p. 121.)

Dr. Hector observed that Mr. Hamilton had been one of the survey officers on board H.M.S. "Acheron," when that vessel was surveying the New Zealand coast, and his statements might be relied on, as he had ample opportunities.

Mr. Hood thought it quite possible that the tarepo still existed, and the evidences of the recent existence of the Moa in the South Island were so numerous that it seemed impossible for persons unprejudiced in favour of a pet theory to doubt it. The negative evidence of the alleged absence of traditions, insisted upon by Dr. Haast and others, even were it proved to be the case, instead of the reverse, would have but little weight when one considered, as Dr. Hector had just shown, how rapidly animals, large and numerous as the bison, pass away almost unnoticed. He questioned if one in a thousand amongst the peasantry of Switzerland could give any distinct description of the beaver —remarkable in its habits, and the evidences of whose labours are so permanent—and yet we know the last beaver was killed there in 1812.

4. "On the Wanganui Tertiaries," by C. W. Purnell. (*Transactions*, p. 453.)

Dr. Hector observed that the author pointed out an unconformity in

breaking up the Lower Wanganui series, which, if established, would have an important bearing on the geology of the district.

5. "Notes on the Microscopic Structure of certain Igneous Rocks submitted by the Director of the Geological Survey of New Zealand," by R. Daintree, F.G.S., Agent-General for Queensland; communicated by Dr. Hector. (*Transactions*, p. 458.)

Dr. Hector stated that specimens had been sent by him to the author, who was formerly Government Geologist in Australia, and was now devoting his attention to this subject. The results of his examinations so far were very interesting, but of a highly technical nature.

The President remarked that this method of examining rocks was a very recent and important advance in science, and he was glad to see that its application to New Zealand was not overlooked.

After the meeting many members remained to examine a large series of sketches made by Mr. W. M. Cooper, illustrating the scenery of the West Coast mining districts, and other parts of the colony.

FOURTH MEETING. 15*th August*, 1874.

Charles Knight, F.R.C.S., President, in the chair.

New members.—Frederick Bull, E. H. Bold, C.E.

1. "Notes on Dr. Haast's supposed Pleistocene Glaciation of New Zealand," by W. T. L. Travers, F.L.S. (*Transactions*, p. 409.)

Mr. Crawford said that, without entering on the subject of glaciation, he must certainly disagree with the author in his view that the S.E. trades prevailed over Australia, and thought that, by his diagram, he had stabbed his own argument with a stiletto of chalk. No doubt it was right and proper that the S.E. trades should blow over Australia, but unfortunately, as a matter of fact, they did not. They only passed over the N.E. corner, and it was well known that hot, dry winds from the N.W. were prevalent along the eastern portions of Australia, at least south of Brisbane.

Mr. J. A. Wilson thought the extent of surface in Australia traversed by the S.E. trades was greater than stated by Mr. Crawford. He agreed with the author that the S.E. trades did blow on the coast of Australia, and thought N.W. monsoons were due to the heated interior of the continent, a view which had escaped the notice of the author of the paper. He did not believe the N.W. winds of Australia reached New Zealand, and they were certainly never encountered on the ocean surface that intervenes; whether or not they were in the higher regions of the atmosphere could only be determined by a balloon. The hot winds of Canterbury, he thought, had nothing to

do with the Australian hot winds, but were due to the evolution of moisture from winds passing over the Southern Alps.

Dr. Hector said the paper just read touched on nearly every branch of the physical geography of New Zealand, and opened a great variety of debatable questions. Mr. Travers considered that Dr. Haast was wrong in the period to which he attributed the glacial conditions, and also in the cause he suggested for them. Agreeing with the author that vague assumptions were unscientific, he had anxiously expected some definition of the meaning that he attached to the terms pleistocene and pliocene, as in that lay the first ground of difference with Dr. Haast. The former word was used by Sir Charles Lyell for certain terrestrial or drift beds that are contemporaneous with newer pliocene; in fact, an extension back in time, in some localities, of post-tertiary conditions. Owing to its frequent mis-application to merely post-pliocene strata, Sir Charles recommended that the term should be dropped, but, if used in its original and extended sense, he (Dr. Hector) thought it would be useful to retain it, and it seemed to him that it would suit Mr. Travers' view, as he understood him to hold that no great change in the fauna and flora of the islands had taken place since the great glacier period. Apart from this verbal consideration, he thought the evidence for classifying even our marine tertiary strata did not, except as a matter of convenience, warrant our applying to them terms that have definite meanings in the other hemisphere, where the geology has been more fully worked out. With reference to Dr. Haast's opinions, the report quoted from so largely was neither his first nor his last, and among them were many views in variance with each other. He did not attach much importance to this so long as the facts recorded were right, as speculations on this and kindred subjects were only muffled echoes of discussion in the old country, where opinions change like the fashions. The extensive citations just made from Geikie's work on the "Great Ice Age" were a case in point. It being a new work, was treated as final authority, but he thought that, even in passages read, there were views that had already been disputed and modified. Leaving the question of whether the glaciers were largest during an extended pleistocene period, or were contemporaneous with pliocene marine deposits elsewhere, which is Mr. Travers' view, as still open, he agreed with the author's idea of the cause of the former great size of the glaciers, though not requiring for his theory such an extreme degree of elevation of the land. He had previously expressed his opinion that there must have been a greater extent of land above the snow line, partly due to increased height, but also due to the more massive form of the mountains before they had been cut up into valleys, ridges, and peaks, but that a third cause may be found in changes in the physical geography of the surrounding region. The winds had been described as blowing steadily from certain quarters which did not bring them

over the Australian continent, but the regular gyration of the winds through successive quarters had been quite overlooked. This rotation is performed in from five to seven days, and through its influence large columns of the atmosphere are transferred from one area to another. Prevalent wind in New Zealand only means that there is a preponderance of wind from a certain quarter, and not a steady wind like the trades. The fact is undoubted that warm winds from the N.W. do impinge on New Zealand, but the only fair way to discuss this subject is by making use of the abundant meteorological data which have been accumulated.

FIFTH MEETING. *29th August*, 1874.

Charles Knight, F.R.C.S., President, in the chair.

1. "Notes upon the probable Changes that have taken place in the Physical Geography of New Zealand since the Arrival of the Maori," by T. H. Cockburn-Hood. (*Transactions*, p. 112.)

The Hon. Mr. Waterhouse said, with regard to the tree mentioned by the author as having been found recently in Auckland, that he did not think there was sufficient evidence to show that it had been felled by human agency, and this discovery could hardly be taken as a proof that these islands were inhabited at so early a date as the paper seemed to indicate. He considered that Mr. Hale's theory regarding the early occupation of New Zealand was open to doubt.

Mr. J. A. Wilson was pleased to hear this large and interesting question referred to. He could not, however, agree with all that the author of the paper had advanced. There was a philological difficulty in the way of the assumption that the Maoris had been long in New Zealand. When Cook first visited these shores, rather more than a hundred years ago, he was rejoiced to find that Tupia, whom he had brought with him from the Friendly Islands, understood the Maoris perfectly. Cook states distinctly that Tupia's language and the language of the Indians were the same, differing only in dialect. Coupling this with the fact that barbarous languages change more rapidly than languages having a literature, and that the latter as spoken 500 years ago are almost unintelligible now, we have reason to infer that the Maori language has not been separated from its parent stem longer than the time mentioned by the natives themselves. That time was from sixteen to eighteen generations ago. The present King Tawhiao was the sixteenth in direct descent from Hoturoa, who landed at Kawhia from Tainui canoe, and the genealogies of the principal chiefs whose fathers came in the various canoes from Hawaiki, will all be found to cover a similar period. The Maori genealogies were good evidence, and could be no more lightly cast aside than

could be the history of the tenure of lands they possessed, and with which history those genealogies were associated. The Maoris tell us that they came together from Hawaiki, that they rendezvoused at Ahuahu—hence the name of that island—and that they found New Zealand inhabited by the descendants of Tara, of Tuwhenua, and of Toe. Some chiefs of the present day trace their lineage to this ancient race, which, judging from the traces we have of their language, was probably a previous wave of immigration from a not very dissimilar source. The early history of this race comes to us through the Maoris, and is lost in mythology. The "ancient men of the island" were hospitable to the Hawaikians, and the latter intermarried with them, but when, in the course of some 200 years, the Maori element had become sufficiently strong wars ensued in many parts of the island, and the ancients were annihilated in the Upper Thames, Tauranga, Rangitaiki, and Uriwera districts. Such wars between the races were, however, not universal, and the East Coast, from Poverty Bay to the Bay of Plenty, was free from them. Mr. Wilson did not think that the recent discovery in the Barrack Hill, at Auckland, could be associated with the Maori race any more than the hand found at the Dôme of Auvergne could be connected with the present people of that place.

Mr. Kirk thought Mr. Hood attached too much importance to the discovery of the tree in question. It was quite true that the stump did bear marks as if cut down by some rude implement, and that a rough stone adze was found at some distance from the tree. He had examined it himself. The cuts from opposite sides made into the tree were at slightly different levels, so that a protuberance marked the mass of wood broken through as it fell. The descriptions of the layers of sand deposited by water, and the volcanic deposits above, were also correct. But until further evidence had been adduced, or a similar discovery made elsewhere, it was rash to decide finally on the subject. He objected to the conclusions that had been drawn, based only on this isolated fact.

Mr. Hood thought Mr. Kirk's observations most satisfactory and convincing. It mattered not with what implement the tree had been felled, as long as it was proved that it had been so by the hand of man, and that its situation left no doubt about its antiquity. Mr. Wilson had pointed out with much force and justice the importance in a discussion regarding the age of the Maori race to be given to the consideration of language—but we could scarcely accept the proposition that the inhabitants of all the various scattered islands of Polynesia have migrated from their original home within the last 500 years. Were it so, there would be some hope of determining even now where that was situated. The dialects have certainly become in places most remote very little altered. He had heard Bishop Selwyn preach in Maori to the natives

of the isolated island of Rapa, by whom he was perfectly understood. The Polynesians were bold navigators, more so probably in early times than now; but even recently the Tongan canoes used to go constantly as far as Nea, or Wallis Island, to bring blocks of porphyry, and the ancestors of those Maori chiefs Mr. Wilson had adverted to may probably be descended from fresh adventurers who came in later times to New Zealand. In this manner communication being kept up from time to time, when perhaps the stepping stones between different groups were less remote than now, the difference in the dialects is less than otherwise might have been the case.

2. "On the Occurrence of *Juncus lamprocarpus*, Ehr., in New Zealand," by Thomas Kirk, F.L.S. (*Transactions*, p. 378.)

3. "Description of a new Species of *Isoëtes*," by Thomas Kirk, F.L.S. (*Transactions*, p. 377.)

Specimens of the plants described were on the table.

4. "On the Analogy of Cyanogen to Oxygen," by William Skey, Analyst to the Geological Survey of New Zealand. (*Transactions*, p. 379.)

5. "On the Evolution of Heat during the Hydration of Clay-slate, Clay, and Coal," by W. Skey. (*Transactions*, p. 384.)

In this paper it is shown that clay-slate, and also anhydrous or dehydrated coal or clay, liberate heat when placed in contact with water, and that this heat is in greater part produced by the combination of water with the substances enumerated. Also, that so-called hygroscopic water is chemically combined with the material retaining it. It is further shown that in cases where chemical substitution occurs in solid matters, heat is generated, and this even in cases where the substituting body has a lower equivalent than that substituted.

6. "Notes on the Formation and Constitution of Torbanite (Bog-head Coal) and similar Minerals," by W. Skey. (*Transactions*, p. 387.)

The author proves that clay absorbs the colouring matter, and also paraffin, from petroleums; and that this is a true chemical absorption. For this and various other reasons connected with it, he suggests that Torbanite, or the famous Torbane Hill mineral used in the manufacture of paraffin, has been formed by the passage of petroleum through clay beds, the solid portion of the oil having been retained by the clay, thus producing either bituminous clay or Torbanite, according to the extent of the process. He believes the ash of this mineral to be an essential part of it, not accidental as now considered. He proposes to utilise this discovery by purifying coloured kerosenes by means of clay, while the bituminous clay thus formed will be useful either for making pigments or as fuel.

7. "On the Position of Sulphocyanogen among the Elements, with Notes upon the Series of double Sulphocyanides discovered by the author in 1868," by W. Skey.

8. "A Description of some new Species of *Gymnostomum*," by Charles Knight, F.R.C.S. (*Transactions*, p. 354.)

Specimens of these plants were laid on the table.

Sixth Meeting. 12*th September*, 1874.

Charles Knight, F.R.C.S., President, in the chair.

New members.—Herbert Gaby, Frank Bailey Passmore, C.E., John Gibson Dees, C.E.

Dr. Hector exhibited a magnificent crystal of carbonate of soda, or the washing soda of commerce, selected from three tons manufactured by Mr. Herbert Gaby at the Wellington Soap and Candle Works, being the first commencement of this new branch of industry in the colony. He stated that the difficulty of procuring oil of vitriol in the colony prevented the manufacture of this and many other useful chemical products. White Island had been mentioned as likely to afford a supply of sulphur for vitriol works, but the sulphur is there found largely mixed with sulphate of lime, and could not be obtained in a pure state in quantity. Still, if the manufacture of plaster of Paris were combined with this process, it might perhaps be made profitable, as the same calcination would yield sublimed sulphur and leave plaster of Paris as a residue. He also exhibited a series of nickel ores, lately analysed in the laboratory, from a new locality, the richest samples containing 14 per cent. of nickel combined with zinc, magnesia, and lime, in a siliceous matrix.

1. "On the Hot Winds of Canterbury," by Alexander McKay, of the Geological Survey Department. (*Transactions*, p. 105.)

Captain Edwin thought the winds described must be of a local character, and that they might not be from the north-west, but receive their direction from the shape of the mountains.

2. "Notes on certain disputed Species of New Zealand Birds," by Walter L. Buller, D.Sc., F.L.S., C.M.Z.S., etc. (*Transactions*, p. 211.)

3. "Memorandum on the Longitude of Wellington Observatory," by Captain Nares, of H.M.S. "Challenger," with enclosing letter by Dr. Hector, F.R.S.; communicated by the Hon. the Colonial Secretary.

Colonial Museum, Wellington, 9th September, 1874.

Sir,—I have the honour to forward a memorandum relative to the longitude of Wellington, which has been addressed to me, as officer in charge of the Observatory here, by Captain Nares, of H.M.S. "Challenger."

It is satisfactory to find that the longitude which is at present used for finding the local New Zealand time is within ·81 of a second of that which is given by the observations now communicated by Captain Nares as the result of the investigations of the officers of H.M.S. "Challenger." Thus, the chart longitude at present used to find the local Wellington time, in accordance with a decision arrived at by the Board appointed in 1870 (App. to Journ.

	H.	M.	SEC.	H.	M.	SEC.
H. of R., D—27), is				11	39	11·53
The longitude for the same, deduced from the longitude now given by the "Challenger" from the Wellington Observatory, is	11	39	07·84			
Pipitea Point, E. ... ... +			2·88	11	39	10·72
Difference						·81

It is true that the longitude, as determined by the absolute observations of Chief Surveyors Jackson and Thomson (App. to Journ., 1871, G—23), would appear to be 11h. 39m. 18·19sec., but this longitude has never been accepted in the practical working of the Observatory, as it would involve the serious consequences pointed out in the latter part of Captain Nares' memorandum; and as it differs from all chronometric measurements, which, in the opinion of the Astronomer Royal and Professor Ellery, are more reliable than absolute determinations, owing to the defects in the lunar tables.

As to Captain Nares' remarks relative to the method at present adopted of giving the time-ball signals, I venture to differ from his conclusion on the subject, as he appears to be under a misconception as to the method which is in use. When a time-ball drops in any part of New Zealand, a ship's chronometer, if set, as is usually the case, to Greenwich Mean Time, should show 12h. 30m., and any difference from this will be the error, fast or slow, on Greenwich Mean Time. The local time at any port can at once be obtained by applying the difference between the chart longitude for that place and 11h. 30m. E., or 172° 30′ E. of Arc. This appears to be as simple a method, both for rating and correcting chronometers, as can well be contrived, and is, besides, in accordance with the practice adopted round the coasts of England and Scotland, where Greenwich time, and not the time at place, is indicated by the local time-balls.

I cannot therefore concur in the suggestion that, in giving the time-signals in different parts of the colony, local mean time at place should be adopted.

As the correct longitude of Wellington Observatory, being the initial longitude for New Zealand, will be required by the officers in charge of the observation of the transit of Venus, I may state that the longitude, as determined from the difference between Sydney and New Zealand, measured by Captain Stokes—and corrected for the error since ascertained for the

position of Sydney—is, in all probability, most correct, having been taken under very favourable circumstances. Thus:—

		H.	M.	SEC.
Melbourne Observatory	E.	9	39	54·80
Difference to Sydney, by telegraphic observation ...	E.		24	55·81
Fort Macquarie	E.			2·63
Difference to New Zealand	E.	1	34	15·53
Probable true longitude of Pipitea Point		11	39	8·77
Wellington Observatory	W.			2·88
Probable true longitude of Wellington Observatory ...		11	39	5·89

This is about two seconds less than the longitude given by Captain Nares, but I think it should be preferred, as he himself points out that the "Challenger" observations were not taken under the most favourable circumstances. —I have, etc., JAMES HECTOR.

The Hon. the Colonial Secretary, Wellington.

Memorandum for Dr. Hector, F.R.S.

The meridian distance between the usual observatory place at Sydney (viz., the Flagstaff at Garden Island) and the Cathedral at Wellington, by the "Challenger's" chronometers, was found to be 1 hr. 34 min. 15·47 sec.

In order to make this meridian distance of use, to determine the longitude of the Observatory at Wellington, it is necessary to know the exact position of that Observatory with reference both to the Cathedral and Pipitea Point. Unfortunately neither of these positions are given on the plans furnished us by the local surveyor, so that we are obliged to have recourse to the small plan of the port published by the Admiralty; and it was also unfortunate that we were unable to observe at Pipitea Point (the position selected by Captain Stokes), but now this has become the railway terminus the vibration of the ground renders it impossible to obtain accurate observations in this locality, and, being at the time unaware an Observatory had been established at Wellington, we chose the Cathedral, as being a building likely to be permanent, and in the vicinity of which good observations might always be obtained.

To compare the meridian distance obtained by us with that of Captain Stokes, both are referred to the Observatory at Sydney and Pipitea Point.

Captain Stokes' meridian distance is—

	H.	M.	SEC.
From Fort Macquarie, Sydney, to Pipitea Point	1	34	15·53
Sydney Observatory west of Fort Macquarie			2·63
Sydney Observatory to Pipitea Point	1	34	18·16

The "Challenger's" meridian distance is—

	H.	M.	SEC.
From Garden Island Observatory △ to Cathedral, Wellington	1	34	15·47
Sydney Observatory west of Garden Island Observatory △			5·73
Sydney Observatory to the Cathedral, Wellington... ...	1	34	21·20
The Cathedral west of Pipitea Point			·87
Sydney Observatory to Pipitea Point	1	34	22·07

Taking the mean of these two results:

	H.	M.	SEC.
Captain Stokes' meridian distance	1	34	18·16
"Challenger's" ditto	1	34	22·07
			2)40·23
Mean	1	34	20·11

The meridian distance between the Observatory at Sydney and Pipitea Point will be 1h. 34m. 20·11sec., and this is probably within half a mile of the truth. It is, however, possible that, in taking the arithmetic mean of these two meridian distances, we are giving our own too great a value, as, owing to bad weather and the delay consequent on sounding for the telegraphic cable from Sydney to New Zealand, twenty-one days elapsed between our observations at Sydney and Wellington.

If Captain Stokes ran his distance directly from Sydney to Wellington, as he probably did, he would certainly have obtained observations at the two places with a less interval of time, and his distance would therefore be of much more value than ours. In the absence of precise information as to how his distance was obtained, we have assumed for the present the two results to be of equal value. The Observatory at Wellington is said to be 2·88sec. west of Pipitea Point, the meridian distance therefore between the Observatories at Sydney and Wellington will be 1h. 34m. 17·23sec.

The next point to determine is the absolute longitude of the Observatory at Sydney. That longitude was determined by Mr. Scott by absolute observations, and he made it 10h. 4m. 47·32sec. E. of Greenwich. Lately telegraphic time signals have been exchanged between the Observatories of Melbourne and Sydney, and the meridian distance found to be 24m. 55·81sec. The longitude of the Melbourne Observatory, as determined by Mr. Ellery, is 9h. 39m. 54·8sec. E. of Greenwich. By absolute determination, therefore, the meridian distance between the two Observatories is 24m. 52·52sec., or 3·29sec. different from the result obtained by telegraph, which result is necessarily correct. It is therefore evident that either one or both of the determinations for absolute longitude must be in error, and this error is most probably in the Sydney determination, as better instruments were used at Melbourne. Assuming, then, for the present that the longitude of the Melbourne Observatory is correct,

	H.	M.	SEC.
The longitude of Melbourne Observatory is	9	39	54·80 E.
Sydney Observatory east of Melbourne...		24	55·81 E.
Wellington Observatory east of Sydney Observatory ...	1	34	17·23 E.
Longitude of the Wellington Observatory	11	39	07·84 E.

The longitude of the Observatory at Wellington may therefore, for the present, be considered as 11h. 39m. 7·84sec. E. of Greenwich. Opportunity

will, no doubt, present itself of verifying and correcting this as soon as the telegraphic cable is laid between New South Wales and New Zealand.

It is perhaps as well for us to point out in this paper that the present method of dropping the ball at Wellington, which method is, we understand, adopted over the whole of the New Zealand islands, is liable to lead to grave error.

It must be evident that in order that a time signal should be of use for purposes of navigation, that signal should be given on a principle which admits of its being readily applied to the charts on which the seaman plots the position of his vessel. These charts are all graduated on a certain system, and on an assumed longitude of a selected position on each sheet, which longitude is the subject of most careful attention at the Hydrographic Office, and every longitude on, or adjacent to, one well-determined position is made to coincide with that position. Thus, every longitude on the published chart of New Zealand is relatively correct with the given longitude of Wellington. Now, the longitude of Pipitea Point on the chart is 174° 47′ 53″ E., while the ball at the Custom House has been dropped at an assumed time of 11h. 30m. from Greenwich, and this assumed time has been taken as being 9m. 15·75sec. west of the Wellington Observatory, or 9m. 18·63sec. from Pipitea Point; therefore the ball was dropped as if Pipitea Point was in longitude 174° 49′ 39″ E., or 1¾ miles east of the position given on the chart. A ship, therefore, rating her chronometers by the ball at Wellington would always be 1¾ miles west of the position plotted on the chart, and this might be of serious moment.

This difference, no doubt, has been caused by the desire of the colony to adopt one mean time for the whole of the islands, an object the advantages of which few people will dispute, and in doing which an error of a minute of time in the absolute longitude assumed as the mean is of no moment. Very different, however, may be the results when that empirical time is used as a standard for seamen. Then every second becomes of consequence, and it is necessary to be most careful that errors are not allowed to creep in. Probably the only way to avoid this is to give a time signal at a certain specified moment (say noon or 1 p.m.) *mean time at place*, which time can always be ascertained correctly, leaving the seaman to apply the difference of time, as denoted on his chart, between the place he is at and the meridian of Greenwich. By this means he will always be certain that the astronomical position of his vessel ascertained by him at sea is relatively correct with the adjacent coast, both being laid off on the same chart.

G. S. Nares, Captain R.N.

Captain Edwin thought that the time-balls should drop to local time, as

otherwise seamen would have to refer their observations to an imaginary meridian.

Mr. George did not see what they could want with observations, as when a seaman is in port he must surely know where he is.

Dr. Hector said the practice at present adopted was the same as round the British coast, where the time signals for shipping are given in one uniform time, being that of Greenwich, and not in the local time for each place. Besides, the inconvenience to the public would be very serious if local time were again resorted to.

The President thought the present system was certainly the best, as the object was to give navigators the correct Greenwich time. He did not see for what purpose they could require local time, but it could be easily obtained by referring to the longitude of the port they were in, as given on the chart, and calculating its difference from the average longitude of 11h. 30m. east, which has been adopted as the mean time for the whole of New Zealand.

4. "Notes on New Zealand Whales," by James Hector, M.D., F.R.S. (*Transactions*, p. 251.)

In this communication the author described the skull of a calf of *Neobalæna marginata*, and some other interesting forms, which he exhibited, and particularly the skull and some other portions of the humpback whale (*Megaptera*, Gray), which he considered to be the same whale as recently described by Dr. Gray as a *Balænoptera*, or finner whale. He also gave an account of a sulphur-bottom whale, seventy feet in length, the skeleton of which he had secured in Port Underwood, and which he considers to be the true *Physalus*, or finner whale. The present list of whales, he thought, would have to be very much reduced in the number of species, and even genera.

Seventh Meeting. 21*st November*, 1874.

Charles Knight, F.R.C.S., President, in the chair.

New members.—Kenneth Wilson, B.A., Edward Toomath.

The President was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act.

The nomination for the election of Honorary Members of the New Zealand Institute was made, in accordance with Statute IV.

1. "On Duplex Telegraphy," by Charles Lemon, General Manager, New Zealand Telegraphs; communicated by W. T. L. Travers, F.L.S. (*Transactions*, p. 396.)

The paper was illustrated by a number of explanatory sections, which

helped to unravel the intricacies of the system, and render it comprehensible to the meeting. The subject was followed up by a very interesting discussion, in which Dr. Knight, Mr. Travers, Mr. Heale, and the Hon. Mr. Waterhouse took part. Upon the motion of the Hon. Mr. Waterhouse, an unanimous vote of thanks was accorded to Mr. Lemon for having placed the paper at the disposal of the society for publication in the Transactions.

2. "On the Occurrence of *Plotus novæ-hollandiæ* in New Zealand," by Walter L. Buller, D.Sc., F.L.S. (*Transactions*, p. 217.)

3. "On the Flowering Plants and Ferns of the Chatham Islands," by John Buchanan, of the Geological Survey Department. (*Transactions*, p. 333.)

4. "Description of some New Zealand Lichens," by Charles Knight, F.R.C.S., F.L.S. (*Transactions*, p. 356.)

The President laid on the table a number of drawings and specimens to illustrate his descriptions.

5. "On the Evolution of absorbed Sulphur from Carbon by Voltaic Action; with Notes upon the Rev. H. Highton's Theory for explaining the Evolution of this Gas from certain Batteries in Work," by William Skey, Analyst to the Geological Survey of New Zealand. (*Transactions*, p. 389.)

Mr. Kirk mentioned having discovered two plants hitherto unknown in New Zealand, namely, *Lepilæna preissii*, Muell., and *Carex chlorantha*, Br.

Before the close of the meeting Mr. Travers exhibited a bottle containing worms found by Mr. Bidwill, of the Wairarapa, in the throat and nostrils of some sheep.

Mr. Waterhouse informed the meeting that these worms were very injurious to sheep, often causing death, no doubt from suffocation.

Mr. Travers thought the worms were taken into the system by the sheep while drinking from stagnant pools, where the worms abound. After some further observations, the meeting adjourned.

Eighth Annual General Meeting. 10*th February*, 1875.

James Hector, M.D., F.R.S., in the chair.

About twenty-five members were present.

ABSTRACT REPORT OF COUNCIL.

The council congratulate the society on the increased attendance at the meetings. Twenty-two new members have been elected, making a total of 161 on the books. Seven general meetings were held, at which thirty-two papers were read. Nearly 200 volumes have been added to the library by

presentation or purchase, including, among others, eighty-five publications from the Geological Survey Department of India and twenty-nine from the Smithsonian Institute.

The council consider that the best way of disposing of a portion of the large balance to the credit of the society is by purchasing good standard works of reference, and they have embraced the opportunity of Dr. Hector's visit to England to request that gentleman to select such books as he thinks suitable for our library. This Dr. Hector has kindly consented to do, and the council have, therefore, placed at his disposal the sum of £100 for the purpose. We may therefore hope soon to have a useful library of reference on all branches of science.

There is also every reason to suppose that, when the extensive additions to the Colonial Museum are completed, arrangements may be made with the Governors of the New Zealand Institute whereby the society may be enabled to secure within its walls increased accommodation, both as regards the library and for the holding of evening meetings.

The balance sheet showed the sum of £162 5s. 8d. to the credit of the society after defraying all expenses.

The chairman announced that Professor Wyville Thomson, Professor Newton, of Cambridge, and Robert McLachlan, Esq., of London, had been elected honorary members of the New Zealand Institute.

Election of Officers for 1875.—*President*—W. L. Buller, D.Sc., F.L.S., F.G.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., and W. T. L. Travers, F.L.S.; *Council*—Hon. W. B. D. Mantell, F.G.S., T. Kirk, F.L.S., J. R. George, C.E., C. C. Graham, Captain Edwin, J. Marchant, H. F. Logan; *Auditor*—A. Baker; *Secretary and Treasurer*—R. B. Gore.

The chairman said he considered the society fortunate in securing Dr. Buller's services for the office. That gentleman had recently returned from England, where he had achieved a well-earned fame amongst scientific men by the production of his recent work, "The Birds of New Zealand," in regard to which he need say nothing, as the merits of the work were well known and generally recognised throughout New Zealand. The compliment they were about to bestow upon Dr. Buller was well deserved, not only on account of his recent book, but also on account of his efforts to establish the New Zealand Society (afterwards changed to the Wellington Philosophical Society), of which he was for some time honorary secretary. His election would, therefore, justly mark those early efforts in the cause of science in New Zealand when it was not so much advanced as it is now.

Mr. Travers (who was not present at the beginning of the meeting), before the business of the annual meeting concluded, proposed a vote of thanks to

Mr. Gore, who had acted as secretary during the past year. The care with which Mr. Gore had kept the accounts of the society and superintended the collection of its money had earned their thanks and that recognition which could only be conveyed by a complimentary vote.

Mr. George seconded the motion, though he confessed he would have been much better pleased had the motion embraced a proposal to add ten guineas to the vote.

Mr. Gore having thanked Mr. Travers and Mr. George for their expressions of opinion in regard to his efforts,

It was resolved that a vote of thanks to Mr. Gore be recorded in the minutes, for his services rendered to the society during the past year.

W. T. L. Travers, F.L.S., Vice-President, in the chair.

1. "Some further Proofs as to the ancient Cook Strait River, and the Harbour of Wellington as a Fresh-water Lake; also, a Consideration of the Date at which the Islands were united," by J. C. Crawford, F.G.S. (*Transactions*, p. 451.)

2. "Notes on Hutton's Catalogue of the Marine Mollusca of New Zealand," by Dr. Ed. von Martens, of Berlin; communicated by Dr. Hector.

3. "On some Additions to the Collection of Birds in the Colonial Museum," by Walter L. Buller, D.Sc., F.L.S., etc. (*Transactions*, p. 224.)

This paper noticed several additions to the list of New Zealand species which had not been hitherto recorded, and called attention to some peculiarities of colouration in specimens of *Anas superciliosa* and *Phalacrocorax brevirostris*, which were exhibited.

Sir David Munro observed that one of the acclimatization societies in the colony proposed to introduce the Swallow. It might be interesting to know that Swallows had been seen several times in Nelson, but that they did not remain there, probably on account of their not being able to procure proper food.

Dr. Buller read an extract from page 142 of his work, "The Birds of New Zealand," which proved that a Swallow which had been shot near Cape Farewell, New Zealand, was identical with the Tree Swallow (*Hylochelidon nigricans*) of Australia.

The extract read continued as follows:—"Mr. Gould informs us that in its own country it is a migratory species, visiting the southern portions of Australia and Tasmania, arriving in August and retiring northwards as autumn advances. In the summer of 1851, Mr. F. Jollie observed a flight of Swallows at Wakapuaka, in the vicinity of Nelson, and succeeded in shooting one, thus placing the matter beyond all question. There can be no doubt that these occasional visitants are stragglers from the Australian continent, and

that to reach our country they perform a pilgrimage on the wing of upwards of a thousand miles!"

4. "Additional Notes on New Zealand Ichthyology," by James Hector, M.D., F.R.S. (*Transactions*, p. 239.)

5. "Further Notes on New Zealand Whales," by Dr. Hector. (*Transactions*, p. 251.)

6. Dr. Buller said that he was glad to avail himself of this opportunity of placing before the society a letter which he had just received from Professor Newton, on the subject of *Rallus modestus*, of the Chatham Islands, and its claim to be considered a good species. It would, no doubt, be in the recollection of those present who took special interest in ornithology, that Captain Hutton some time ago recorded a new species of Rail from the Chatham Islands, as forming part of the novelties collected by Mr. Henry Travers. One of the specimens obtained was forwarded to England, and on examination he (Dr. Buller) pronounced it to be the young of a rare species already known to science (*Rallus dieffenbachii*), of which only one adult specimen exists in the British Museum. In this view he was confirmed by the concurrent opinions of several leading ornithologists to whom the birds were submitted. Captain Hutton, however, having obtained fresh evidence on the subject from Mr. Henry Travers, maintained the validity of his new species, and forwarded specimens of the skin and skeleton to Professor Newton, of Cambridge, whose judgment on any critical point in ornithology all parties would be inclined to accept as final. The result of this reference was favourable to Captain Hutton, and he (Dr. Buller) was only too glad to welcome *Rallus modestus* into the ranks of true and accepted species. The extract from Professor Newton's letter, which he was about to read, illustrated the importance of securing, whenever it was possible, the skeleton, or at any rate the sternum, of any bird supposed to be new or unknown; for, in the present instance, it would have been quite impossible without this aid to determine satisfactorily the point at issue between himself and Captain Hutton. Professor Newton writes, under date 13th December, 1874:—

"As to *Rallus modestus*, I wrote some time ago to Hutton, telling him that I had placed the specimens in Murie's hands, and that he has been *very carefully* working them out. The result was to have been in the next number of 'The Ibis,' but I hear from Salvin (who is now domiciled here as 'Strickland Curator') that it is doubtful whether he can get it in, especially as Murie has been much delayed by illness and other work from completing it. However, the long and short of it is that *Rallus modestus* is a perfectly good species, and belongs to the Ocydromine group of *Rallidæ*, as Hutton suggested, but with some hesitation, a year or more ago. The existence of so small a form of *Ocydromus* is a very interesting fact."

The chairman, before the close of the meeting, took the opportunity to observe that the cause of science generally in New Zealand would be greatly advanced by Dr. Hector's visit to Europe, especially as he would take with him a large and valuable collection of specimens of natural history and other objects. He very much feared that the voyage, which afforded a great deal of leisure to most people, instead of being a rest to him, would be attended with a very great deal more labour than if he were to remain at home. However, with Dr. Hector it would be a labour of love, and he knew, by the valuable assistance Dr. Hector had rendered the colony, that he would be a welcome guest amongst those gentlemen at Home who took an interest in all scientific matters concerning New Zealand. He was sure they all wished Dr Hector "God speed," and trusted they would soon see him back again, to take that active part in assisting to develope the natural resources of the colony, from which so much advantage had been derived in the past.

Dr. Hector briefly returned thanks for the kind wishes expressed, intimating, at the same time, that he hoped to return before very long with a handsome collection for the Museum, in exchange for the specimens he was about to take Home with him.

AUCKLAND INSTITUTE.

FIRST MEETING. *4th May*, 1874.

T. Heale in the chair.

New members.—J. Adams, B.A., Rev. J. Bates, E. B. Dickson, B.A., S. J. Lambert, F.R.A.S., Rev. C. M. Nelson, M.A., Rev. G. Smales.

The secretary read the list of donations to the library and museum.

The chairman delivered the following anniversary

ADDRESS.

The unavoidable absence of our highly-honoured President, which must be a subject of regret to us all, is specially so to me, upon whom has devolved the task of opening this year's session at a notice far too short to enable me to prepare an address worthy of the occasion. Besides, it has always been a favourite view of mine, which I have repeatedly propounded from this chair, that our great object should be not to be only natural history collectors, but that our Institute ought to be a centre where men can meet to exchange their thoughts on every scientific subject, and that we should use every endeavour to make our meetings interesting and popular. Nothing could be more conducive to success in this object than to meet under the presidency of a gentleman of the professional and social standing of him who has kindly undertaken the duty this year—one whose large mental accomplishments are rendered more effective by a happy command of classical and expressive language, and are adorned by a flowing courtesy doubly graceful in the position he occupies.

Our programme is so extensive that there is more than room for workers of every class amongst us ; for the man of general reading, as well as for the botanist or geologist. The laborious collectors, carefully investigating and recording facts, must always hold the first place of honour with us, for their work is useful, not only to us, but to the whole world of science ; but plenty of scope remains for those who have no special study. In a colony like this there can be little room or opportunity for the master workman, capable, by a life of study, of combining into the grander generalizations of science the innumerable facts now streaming in from keen-eyed observers in all parts of the world. Such investigators are all but impossible, except at or near the great centres of population and in the midst of the highest appliances. No

colony can hope to produce a Darwin, a Helmholtz, a Joule, a Mayer, a Huxley, or a Tyndall; any colony may think itself fortunate which can secure the presence of a Hector, a Hutton, or a Kirk.

But though we cannot hope to see produced amongst us great original investigators or generalizers—though few or none of us have the opportunity even to verify experimentally those discoveries which we read of in the proceedings of the scientific societies elsewhere—shall we, therefore, neglect or ignore them? Shall we allow to pass unheeded those great expansions of thought, those splendid views of the universe we live in, which have arisen from modern discoveries, and which are profoundly altering the very bases of our physical reasonings and upsetting or remodelling notions which, in my early days, were considered axiomatic? Shall we allow those great waves of thought, which in Europe are traversing intellect at a depth hitherto unknown, to produce no ripple here, and, by our indifference, leave the rising minds of the colony to stagnate in contented ignorance? Gentlemen, I conceive that one of the chief aims of these affiliated institutes is to keep alive an interest in the higher branches of science, and that it is a paramount duty to open a vision, or at least a glimpse, of the greater scientific speculations of the day to those who may be growing up scarcely knowing, and little heeding, their existence.

Thus it appears to me that there is in our Institute an unlimited field for the action of members, who though, like myself, not devoted to the pursuit of any science, and who would utterly disavow the name of scientific men, yet who, in the course of their reading, are led to examine and to digest, more or less critically, what is going on in scientific circles at Home, and who may be enabled, as I fear I am not, to reproduce some portion of their reading in a manner possibly to attract attention and provoke thought and discussion, though not in itself of a quality to instruct. Pursuing this view, then, I propose to lay before you some slight sketch, chiefly extracted from two or three of the papers which were read before the meeting of the British Association, which met at Bradford in September last, and especially to say a few words on the life and work of that admirable philosopher, Dr. Joule, of Manchester, who was nominated for its president, but who was precluded from occupying the post by the state of his health.

Dr. Joule's name will ever be remembered in connection with the determination of the dynamic equivalent of heat: a most important step towards the grandest generalization of our day—the Conservation of Energy—involving, as it does, the identity of heat, light, and force, and clearly tracing every form of motion, whether mechanical or muscular, whether in the form of electricity, of heat, or light, or of chemical action, to one kind of energy, the whole derived in our astronomical system from its centre, the sun;

in the words of Tyndall: "The great and now universally received doctrine, that throughout the universe the sum of potential and actual energy is *constant;* that to create or annihilate energy is as impossible as to create or annihilate matter, and that all the phenomena of the material universe consist of transformations of energy alone." (Tyndall, "Heat," 132.)

Now, if heat and force are convertible, and are really one and the same thing in different forms—as had been suggested more or less clearly by many philosophers ever since Bacon—then there must be some definite quantity of heat corresponding to, nay, in fact, identical with or equivalent to, a given amount of force; and until this relation was established on undeniable data the doctrine was an hypothesis only, and not a theory.

This relation Dr. Joule, a man actively engaged in other pursuits, set himself to determine by direct experiments, planned and effected with an ingenuity as admirable as the perseverance which carried him over the comparative failures of several years. A little preceding him, Dr. Mayer, of Heilbronn, had thought out the same result, but it needed the patient industry of Joule to confirm it by irrefragable evidence. Commencing in 1843, and continued to 1849, Joule endeavoured, by extremely varied methods, to ascertain exactly the effect in foot-pounds which arises from warming one pound of water 1° of Fahrenheit: his results ranged in the earlier years from 1040 foot-pounds to 770, discrepancies which arose from the inevitable imperfections in the elaborate and delicate appliances and precautions required for such very subtle investigations, but by the later period named these difficulties had been so far overcome that the variation between the highest and lowest of his determinations in 1849 was reduced to less than 1-340th part; and the contemporaneous reasonings and inferences of Mayer having led him to a very nearly identical but slightly lower number; the actual equivalent of heat has been, I believe I may say, universally adopted as 772 foot-pounds. To quote the words of Dr. Carpenter, in his presidential address to the British Association, last September: "The unit of force which all scientific men, in all parts of the world, now accept, on the basis of Dr. Joule's researches, as expressing the equivalent of heat and mechanical force—that unit is called a Joule."

It is scarcely possible to over-estimate the changes in all branches of the analytical study of nature which result from this doctrine of the Conservation of Force, and the recognition of the constantly active forces of the molecules of all matter, which necessarily flows from it. By it every view of chemistry and physics has been modified, and all, but especially those forms of chemical action which result in the development of electricity, have come to be understood in a manner as widely different from, and as much clearer than, those which prevailed in my youth, as the motions of the heavenly bodies were after the establishment of the Copernican System. The observation, for instance,

was long ago made, as a vague generalization, that the fuel we are now using, and from which we derive those vast stores of power which are now available for the service of man—to perform the minutest labour, in weaving the finest fabrics, or to drive the vast steamship across the Pacific—is produced by the sunshine of ages long past, stored away in the great deposits of coal, resulting from ancient vegetation; or as George Stephenson, with a sagacity of mind in advance of the science of his day, answered, when asked what was the ultimate cause of motion of his locomotive engine, "that it went by the bottled-up rays of the sun." But this brilliant suggestion has not merely now become a truism apprehended by every one, but we can at once calculate the quantity of energy so stored up, and ascertain in accurate measure the light and power which lie there dormant, and which may again be brought forward for the use and at the will—it may be for the destruction—of man.

Dr. Siemens, in a remarkable lecture given on the occasion I have so often referred to, says:—"But you will ask what is heat, that it should be capable of coming to us from the sun, and of being treasured up in our fuel deposits, both below and on the surface of the earth? If this enquiry had been put to me thirty years ago I should have been much perplexed. By reference to books on physical science, I should have learnt that heat is a subtle fluid, which, somehow or other, had taken up its residence in the fuel, and which, upon ignition of the latter, was sallying forth either to vanish or to abide elsewhere; but I should not have been able to associate the two ideas of combustion and development of heat by any intelligible principle in nature, or to suggest any process by which it could have been derived from the sun and petrified, or, as the empty phrase ran, rendered latent in the fuel. It is by the labours of Mayer, Joule, Clausius, Ranken, and other modern physicists, that we are enabled to give to heat its true significance. Heat, according to the dynamical theory, 'is neither more nor less than motion among the particles of the substance heated, which motion when once produced may be changed in its direction and nature, and thus be converted into mechanical effect, expressible in foot-pounds or horse-power. By intensifying this motion among the particles it is made evident to our visual organ by the emanation of light, which again is neither more nor less than vibratory motion imparted by the ignited substance to the medium separating us from the same.' According to this theory, which constitutes one of the most important advances in science of the present century, heat, light, electricity, and chemical action are only different manifestations of energy of matter, capable of being changed from the one form of energy to another, but being as indestructible as matter itself. Energy exists in two forms, 'kinetic energy,' or force, manifesting itself to our senses as weight in motion, as sensible heat, or as an active electrical current, and 'potential energy,' or force in a dormant condition. In

illustration of these two forms of energy, I will take the case of lifting a weight, say, one pound one foot high. In lifting this weight 'kinetic muscular energy' has to be exercised in overcoming the force of gravitation of the earth. The pound weight, when supported at the higher level to which it had been raised, represents potential energy to the amount of one unit or foot-pound. The potential energy may be utilized in imparting motion to mechanism during its descent, whereby a unit amount of 'work' is accomplished. A pound of carbon, then, when raised through the space of one foot from the earth represents, mechanically speaking, a unit quantity of energy; but the same pound of carbon being separated or lifted away from oxygen, to which it has a very powerful attraction, is capable of developing no less than 11,000,000 foot-pounds or unit quantities of energy whenever the bar to their combination, namely, excessive depression of temperature, is removed—in other words, the mechanical energy set free in the combustion of one pound of pure carbon is the same as would be required to raise 11,000,000 pounds weight one foot high, or as would sustain the work we call a horse-power during five hours thirty-three minutes," a proportion of power, I may observe, enormously greater than that which it has yet been found possible to obtain in practice.

Again, only a very few years ago the teaching of chemistry all leant on the statical theory; that is to say, it was taken for granted that when a particle, of an acid for instance, had combined with an equivalent of base to form a neutral salt, that the energies of the constituents were exhausted, or at all events dormant, until again called forth by a stronger elective affinity. In words which I quote from the address of Professor Williamson, "these chemists only took cognizance of those changes of place amongst the atoms of the re-agents they dealt with, which resulted in the disappearance of the molecules employed and the appearance of new molecules formed by their reaction on one another; thus, when a solution of common salt (chloride of sodium) is mixed with a solution of nitrate of silver, it is well known that the metallic atoms in these respective compounds change places with one another, forming nitrate of soda and chloride of silver; for the silver salt soon settles to the bottom of the solution in the form of an insoluble powder, while the other product remains dissolved in the liquid. But as long as the solution of the salt remained undecomposed, each little molecule of it was supposed to be chemically at rest." But the author of the paper from which I am quoting—Professor Williamson—pointed out, many years ago, that molecules which appeared to be chemically at rest are reacting on one another when in suitable conditions, in the same kind of way as those which are manifestly in a state of chemical change; that is, that the forces are not dead or exhausted by the act of the entering of the molecules into a stable combination, but that they

remain in full activity; the combination is not statical, but dynamic, and if stable is so only because the forces are momentarily in equilibrium.

Again, in the operations of galvanism or electro-magnetism, which have become so familiar in our times, there is now no sort of difficulty in conceiving the idea which, when propounded by Faraday some thirty years ago, seemed so difficult and perplexing to most minds.

When the operator in the telegraph office presses the knob of his break circuit key, perhaps 100 or more times in a minute, what happens by which the signal is conveyed perhaps many hundreds of miles off? Why, that every molecule in that prodigiously long wire swings to the touch, and reverses its vibrations as often as the circuit is completed and broken. While the notion was yet fresh in men's minds that a mass of matter, as a stone or a piece of metal, was quite inert, its parts in a condition of stable equilibrium, the conception of such free molecular motion as would allow each particle to change its positive for its negative pole every time the direction of the current through it was reversed, seemed indeed incredible. Again, crystallization was held, in the older books, to imply necessarily that the crystalline matter had passed into that condition from a liquid condition, because in that condition only could it then be conceived that motion or action among the molecules could take place; and the very practical fact that iron that had certainly once been fibrous in structure had become crystalline while actually in use, as a railway axle, or in some position subject to great strains and vibrations, seemed to involve inexplicable difficulties. But now that the idea of statical equilibrium is well nigh obsolete, that the dynamic theory of heat and force is well established, and it is recognised that every molecule is for ever vibrating in obedience to unvarying laws, but with ever-varying velocity, and in waves of constantly changing amplitudes and rapidity, and with force before which all the power which man can wield is absolutely insignificant—in a word, that all nature is alive and not dead—then, though the wonder is increased, the power of conceiving it is vastly expanded, and phenomena which appeared incredible and inconceivable when isolated become comparatively simple and luminous when they form part of an universal and connected system. It would be quite out of place for me to go into the details of the experiments of Dr. Joule, and the many others who have followed him, in determining the mechanical co-efficient of heat, or to expatiate further on the larger doctrine of the Conservation of Energy, in which it plays an important part. Such subjects would serve admirably for many of our members who, like myself, amuse their leisure with the literature of science. There are, I have no doubt, very many amongst us far better acquainted with the progress of modern science than I am, and I hope that by their help we shall at least show so large an interest in its culture here

that the rising generation of colonists may see that such questions are not wholly neglected by their seniors, and that some, at all events, protest against the servile belief that useful knowledge is confined to that which is of assistance in the pursuit of wealth.

The spread amongst all classes of a conception of, and a taste for, science is one of the leading objects of the British Association, to the meeting of which, last September, I have so much referred. With this view it holds its meetings at different places, now in Yorkshire, lately in South Wales, and its success cannot be gainsaid. These various affiliated branches of the New Zealand Institute have something of a similar mission. Let us all do our best, each in his own speciality, to collect, to observe, to enrich our museum, and to give value to our published proceedings. But let those who have no speciality combine those general scientific facts and views which can be collected from scientific literature in a form to enliven our meetings and make them attractive and instructive, and at least to show that we take an interest in everything that pertains to science—that if we cannot be leaders we are at least attentive learners, and, as far as in us lies, are willing to be active propagators of scientific thought.

1. "On Trees suitable for Streets and Avenues," by D. Hay.

(ABSTRACT.)

The following species were stated by the author to be best adapted for this purpose:—Lombardy poplar *(Populus fastigiata)*, elm *(Ulmus campestris)*, lime *(Tilia europœa)*, sycamore *(Acer pseudo-platanus)*, *Ailanthus glandulosus*, *Virgilia capensis*, *Acacia melanoxylon*. Mr. Hay also drew attention to the necessity of the Government taking action to prevent the wholesale destruction of forests by bushmen, and, also, that the timber should be cut in the proper season. Between April and August was, in his opinion, the best time.

Mr. C. O'Neill asked if it would be possible to acclimatize the jarrah tree in New Zealand. Such an introduction would be most valuable, in consequence of the great usefulness of the timber.

Mr. Gillies dissented from the views expressed by Mr. Hay in regard to the kind of trees which ought to be planted in avenues. He considered that evergreens ought to form by far the largest proportion. In reference to the conservation of forests, when they considered that every tree cut down now was the product of perhaps 100 to 200 years, they could form some idea of the scale on which planting ought to be carried on.

Dr. Purchas considered that for street planting deciduous trees were preferable to evergreens, although he would not object to see evergreens mixed with them. Some of the New Zealand trees might be preserved, but many of them could not resist the advances of civilization, and, like the native birds, would in time almost entirely vanish. It was a natural result, and they must

not bemoan it, but rather make preparations for filling their place with trees that would live and bear cultivation. He mentioned the district between Papakura and the shores of the Manukau as well suited for planting on a large scale.

Mr. Barstow said that the destruction of forests was owing more to fire than to the bushman's axe, and thought a law ought to be passed, inflicting penalties upon persons endangering forests by lighting fires. He did not think that the extinction of the native trees would happen with such rapidity as Dr. Purchas imagined, if ordinary care was used.

Mr. Lodder thought that the question of cutting timber out of season was a most important one. The Legislature should be asked to prohibit mill-owners from pursuing the practice. Under present circumstances it was impossible to procure timber the quality and soundness of which could be depended upon, and great loss was thereby occasioned, both to Government and to private individuals.

A vote of thanks was passed to the chairman for his address.

Second Meeting. 1*st June*, 1874.

The Rev. A. G. Purchas, M.R.C.S.E., in the chair.

New member.—D. M. Luckie, M.H.R.

The secretary read the list of donations to the library and museum.

Mr. Heale drew the attention of the meeting to the urgent necessity existing for increased accommodation for the museum and library. He briefly sketched the outlines of several plans which had been under the consideration of the council, and invited an expression of opinion as to the best course to be adopted.

A long discussion ensued, which was at length adjourned without any definite conclusion being arrived at.

1. "On Probability," by the Rev. R. Kidd, LL.D. (*Appendix.*)

Mr. Adams took exception to several of the statements made by Dr. Kidd. He particularly objected to the use of the term "science of probability," from the fact that however high a degree of probability might belong to a proposition, yet it could never reach a scientific certainty. He argued that the term "science" could not legitimately be applied to a study the results of which were necessarily so vague and uncertain.

2. "On the Fertilization of *Acianthus* and *Cyrtostilis*," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 349.)

Coloured drawings of the species described were exhibited.

3. "On Street Planting," by R. W. Dyson.

The author recommended that the Improvement Commissioners should at once plant the streets in course of formation by them with limes, chestnuts, and weeping willows.

Third Meeting. *29th June*, 1874.

His Honour Sir G. A. Arney, President, in the chair.

The secretary read the list of donations to the library and museum since the last meeting.

A letter was read from Mr. Martin, suggesting that training schools for instruction in practical science might be advantageously established in connection with the Institute, and that accommodation for such schools should be reserved in the new building proposed to be erected by the Institute.

Mr. Heale considered the proposition an excellent one, and stated it was necessary that immediate action should be taken in the erection of buildings.

The Hon. Mr. Chamberlin thought that a large proportion of the funds required for building could be obtained by establishing life memberships of £100 each. He had little doubt that thirty gentlemen could be induced to become life members, and advance a sum of £100 each, on condition that the privileges of membership were extended to their families as well as to themselves. He himself was willing to become a life member on these terms.

A long discussion ensued, in which the Rev. Dr. Purchas, the Hon. Colonel Haultain, Mr. Martin, and the chairman took part.

1. "On the Discovery of a cut Stump of a Tree, giving Evidence of the Existence of Man in New Zealand at or before the Volcanic Era," by J. Goodall, C.E. (*Transactions*, p. 144.)

The Hon. Col. Haultain did not think that the markings on the stump exhibited by Mr. Goodall could be referred to human agency, but was inclined to suppose that they were produced by the action of running water. He had recently observed at Awhitu some waterworn stumps, the remains of old pas, which presented almost exactly similar appearances.

The Rev. Dr. Purchas expressed a similar opinion.

Mr. Heale thought there could be no doubt the cut was made by some instrument wielded by the hand of man.

2. "Description of a new species of *Senecio*," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 348.)

3. "What is Science?" by the Rev. R. Kidd, LL.D. (*Appendix.*)

FOURTH MEETING. *27th July*, 1874.

His Honour Sir G. A. Arney, President, in the chair.

New members.—J. Chambers, R. J. O'Sullivan, M. H. Payne, M.D.

The list of donations to the museum and library was read by the secretary.

An interesting discussion took place on Mr. Goodall's paper, read at the last meeting, "On the Discovery of a cut Stump, giving Evidence of the Existence of Man in New Zealand at or before the Volcanic Era." The majority of the members present appeared to dissent from Mr. Goodall's views on the subject.

1. "On *Pterostylis squamata* in New Zealand," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 352.)

2. "The Claims of Science in National Education," by Josiah Martin. (*Transactions*, p. 168.)

FIFTH MEETING. *26th August*, 1874.

His Honour Sir G. A. Arney, President, in the chair.

New members.—W. Errington, C.E., C. Lysnar, A. V. Macdonald, C.E., Ingham Stephens.

The list of donations to the museum and library since the last meeting was read by the secretary.

1. "Deep Sinking in the Lava Beds of Mount Eden," by J. C. Firth. (*Transactions*, p. 460.)

This was an account of the different strata met with in sinking a well at the base of the cinder-cone of Mount Eden. The author exhibited specimens from strata, marked *a, b, c, d,** which he stated would be placed in the Auckland Museum for reference.

2. "Early Instruction," by J. Adams, B.A. (*Transactions*, p. 175.)

The Rev. Dr. Purchas was glad that this subject had been brought before the notice of the Institute. While agreeing in many respects with the opinions expressed by Mr. Adams, he yet did not take such a hopeless view of the subject. Many changes for the better had been made in late years, and he thought that the tendency was to admit still further improvements.

3. "Notes on the Origin of Mottled Kauri," by James Stewart, C.E. (*Transactions*, p. 376.)

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* See Transactions, p. 461.

Sixth Meeting. 21*st September*, 1874.

His Honour Sir G. A. Arney, President, in the chair.

New members.—G. Johnston, R. Rose, Lieutenant T. C. Tilly, R.N.

Mr. T. Kirk, F.L.S., of Wellington, was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act.

The nomination for the election of honorary members of the New Zealand Institute was made, in accordance with Statute IV.

An animated discussion took place on Mr. Firth's paper, on "Deep Sinking in the Volcanic Beds of Mount Eden," read at the last meeting. Messrs. Stewart, Goodall, and Pond were amongst the speakers.

1. "Notes on the Chemical Properties of some of the Strata from Mr. Firth's Well at Mount Eden," by J. A. Pond. (*Transactions*, p. 405.)

2. Mr. T. F. Cheeseman read some extracts from a diary kept during a botanical tour through the northern part of the Province of Auckland, and exhibited a series of specimens collected on that occasion.

Seventh Meeting. 26*th October*, 1874.

His Honour Sir G. A. Arney, President, in the chair.

New members.—J. Curnow, B.A., F. D. Kent.

The secretary read the list of donations to the library and museum.

Remarks were made by various members on the paper read by Mr. Pond at the last meeting.

1. "Note on *Danais berenice*," by T. B. Gillies, M.H.R.

Herewith I present to the Institute three specimens of the large handsome butterfly identified by Mr. Fereday (Trans. N.Z. Inst., Vol. VI., p. 183) as *Danais berenice*. These were taken in February last at Hokianga, and sent me by my friend, Mr. Von Stürmer, R.M., who informs me that he has observed them in that locality for several years past. Two years ago I saw specimens taken at Whangarei by Mr. Mair and Mr. Reyburn, who had observed them in that locality for about two or three years before that time. One specimen was also observed in my garden at Mount Eden two years ago, but not captured. It will thus be seen that its occurrence in New Zealand is not uncommon, and can scarcely be said to be intermittent.*

* In a letter to me, dated Hokianga, 1st December, 1874, Major Von Stürmer writes,—"About those butterflies, *Danais berenice*.—The eggs are laid in the early part of February, and the grub changes his skin four, five, and six times. At the end of forty to forty-five days it spins a small web, and hangs itself by its tail; and in four or five days becomes a chrysalis, the most beautiful green and gold that can be imagined. It

2. "Note on the Habits of *Gerygone flaviventris*," by T. B. Gillies, M.H.R.

On Wednesday, 7th October instant, in passing along the road from Russell (Bay of Islands) to Tikiora, in company with Dr. Hector and Professor Berggren, I observed, depending from the twig of a manuka bush close to the roadside, and about five feet from the ground, what appeared to be a bunch of moss. On examining it I found it to be a nest of the *Gerygone flaviventris*, containing four eggs. The nest (which, with one of the eggs, I present herewith) is of the shape of a soda-water bottle, eight inches in length, by about four in diameter at its widest part. The side aperture is fully one-third way down from the twig on which it hung, and measured one and a-half inches across, by about one inch perpendicular. The upper portion of the nest somewhat overhangs the aperture, forming a sort of hood. The nest is composed of twigs, grass, cowhair, and greenish spider nests, with a white coral-like moss scattered over the outside. The eggs are ten-sixteenths of an inch in length, by seven-sixteenths of an inch greatest diameter, ovoid, of a faint pinkish colour, with small brown spots, more numerous at the wider end of the egg. How the long-tailed cuckoo (*Eudynamis taitensis*) can, as stated by Dr. Buller,* deposit its eggs in such a nest I can scarcely understand. On 22nd instant one of my children discovered, under a large *Cupressus macrocarpa* in my garden, a specimen of the *Eudynamis taitensis* recently killed, apparently by a hawk. It would have been impossible for the *Eudynamis* to have entered the opening in the nest of the *Gerygone*.

3. "On Forest Culture," by J. C. Firth. (*Transactions*, p. 181.)

Mr. Gillies did not agree with Mr. Firth, that for the immediate future we should confine ourselves to the planting of *Eucalypti* and *Coniferæ*. There were many objections against the extensive planting of *Eucalypti*. It would be scarcely necessary to do so in the north with the object of inducing moisture, as the country was so narrow that it derived abundant moisture from the sea. This was one of the questions which it would be better for them to consider in a commercial than in a political aspect. It was one of those things which could be better undertaken by the people, who understood it, than by the Government, who did not. Tables had been furnished to show that the country had been denuded of its forests to a great extent, and it had been stated that thousands of acres had been destroyed by bushmen lighting their pipes, and that saw-mill proprietors wasted tremendous quantities of

remains in this state fifteen to twenty-two days, according to heat of place, etc., and emerges the perfect insect. The caterpillar is very handsome—smooth skin, pale yellow ground, with black and purplish bands round the body, and four long black horns, two just above the head, and two at the extremity of the tail. I have sown lots of the seed in the bush of the plant that it feeds upon (I call it the scarlet cotton), so have hopes that the animal may become plentiful. I reared upwards of twenty from the eggs last year, and let most of them go to increase and multiply."

* Birds of New Zealand, p. 75.

timber. But if they looked into the absolute facts they would come to a different conclusion. They would find that it was simply the natural requirements of the people and the necessities of trade that had to be met. At first, bushmen selected the best trees, but now the timber trade had increased to such dimensions that the saw-mill proprietors cut down all trees that were suitable, and utilised even the branches, by splitting them into shingles. In his opinion, the idea of conserving our native forests to the extent proposed by Mr. Firth was quite Utopian.

ANNUAL GENERAL MEETING. 15*th February*, 1875.

T. Heale, in the chair.

New members.—Captain T. Brown, W. F. Buckland, W. Rattray, J. Ronaldson, J. Y. Stevenson, J. M. Tunny, W. H. Williams.

The secretary read the list of donations to the library and museum during the last month.

ABSTRACT OF ANNUAL REPORT.

Seven meetings have been held during the past year, at which seventeen papers were read.

Special thanks are due to Captain F. W. Hutton, for a complete skeleton of *Dinornis crassus*, and to Dr. Ford, for a nearly complete set of the 'Lancet.' Many other valuable donations have been made to the museum and library, notably by Mr. J. Goodall and Mr. W. Earl.

The Provincial Council has made a grant of £100 to the library, and 100 volumes are now on the way from England.

The council recommend that an attempt be made to form a building fund and erect a new museum at once on the present site, plans for such building having been already prepared.

The receipts for the year ending 10th February, 1875, including a balance from last year of £107 5s., amount to £434 19s. 10d., and the expenditure to £321 1s. 1d., leaving a balance of £113 18s. 9d. in hand. The entrance fees and subscriptions amounted to £207 18s., while £112 16s. 10d. was spent in the purchase of books and periodicals.

ELECTION OF OFFICERS FOR 1875.—*President*—J. C. Firth; *Council*—J. L. Campbell, M.D., J. M. Clark, W. Earl, G. F. Edmonstone, T. B. Gillies, J. Goodall, C.E., Hon. Colonel Haultain, T. Heale, Rev. J. Kinder, D.D., G. M. Mitford, J. Stewart, C.E.; *Secretary*—T. F. Cheeseman, F.L.S.; *Auditor*—C. Tothill.

Plans and estimates of a building proposed to be erected for a museum and library were then exhibited; and the chairman spoke urging the meeting to come to some definite conclusion on the subject.

After considerable discussion, and after several motions had been made and withdrawn, it was proposed by Mr. Goodall, seconded by Mr. Pond, and carried unanimously :—

1. "That the time has now arrived when the erection of new and suitable buildings for the Museum and Institute can be no longer delayed.

2. "That with the view of forwarding the construction of such buildings, a subscription list be immediately opened towards the building fund.

3. "And that the council be authorized and instructed to take every step, by application to the Government and public, to carry out this object forthwith."

It was then resolved, "That a vote of thanks be given to the retiring President (His Honour Sir G. A. Arney) for his valued services during the past year."

A subscription list was at once opened in aid of the building fund, when the Hon. James Williamson subscribed his name for £500, and "Anonymous" for a similar amount. Numerous other donations were also received.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Second Meeting. *2nd April*, 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New member.—Rev. C. Turrell.

1. "On the Occurrence of *Hæmatococcus sanguineus* on the Wool of a dead Sheep," by Swen Berggren, Ph.D.; communicated by the President. (*Transactions*, p. 369.)

2. "On *Wolffia*, the smallest flowering Plant known, discovered by Baron F. von Mueller in Mount Emu Creek, in Australia," by Ll. Powell, M.D.

3. "On the Occurrence of *Lamna cornubica*, the Porbeagle Shark, in New Zealand," by Julius Haast, Ph.D., F.R.S. (*Transactions*, p. 237.)

The President remarked on a new method of preserving Lepidoptera, invented in Paris, and exhibited specimens.

The President also exhibited some "Message-sticks" of the natives of Western Australia, presented to the museum by his Excellency Governor Weld.

Third Meeting. *7th May*, 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New member.—J. S. Guthrie.

"On the Disappearance of the larger Kinds of Lizard from North Canterbury," by the Rev. J. W. Stack, M.A. (*Transactions*, p. 295.)

Fourth Meeting. *4th June*, 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

No papers were read.

Fifth Meeting. *2nd July*, 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New member.—A. R. Inwood.

"Note on the colouring Matter of *Hæmatococcus sanguineus*," by Ll. Powell, M.D. (*Transactions*, p. 404.)

Sixth Meeting. *6th August*, 1874.

G. W. Hall, Vice-president, in the chair.

New member.—Professor A. W. Bickerton.

No papers were read.

Seventh Meeting. *3rd September*, 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

Several presents from the Smithsonian Institute, Washington, were laid on the table.

The President read an extract from a letter of Comme Giordano, Inspector of Mines of the Kingdom of Italy, respecting the formation of the Canterbury plains.

Eighth Meeting (Special). *15th September*, 1874.

G. W. Hall, Vice-president, in the chair.

1. "Description of a new Crustacean (*Phronima novæ-zealandiæ*)," by Ll. Powell, M.D. (*Transactions*, p. 294.)

2. "On the Occurrence of *Leptocephalus longirostris*, Kaup, on the Coast of New Zealand," by Julius Haast, Ph.D., F.R.S. (*Transactions*, p. 238.)

3. "Results of Excavations and Researches in and near the Moa-bone Point Cave, Sumner Road, illustrated with maps, selections, and ethnological specimens," by Julius Haast, Ph.D., F.R.S. (*Transactions*, p. 54.)

To this paper the following postscript was appended :—

Postscript.—In the *Press* of 13th August of this year I observe a paragraph headed "The Sumner Cave," being a résumé of a paper read by Dr. Hector before the Philosophical Society in Wellington, for A. McKay, on the excavations made by me in that locality, end of 1872, and during which the said A. McKay was one of the labourers employed by me.

According to the *Press*, the summary of the *New Zealand Times* begins with the following sentence :—

"The exploration occupied seven weeks, and on its completion the collections and notes which were made were given to Dr. Haast, and the paper now read was chiefly occupied with the author's own views on the question—whether the moa-hunters were possessed of tools other than those of the rudest description, and whether there were any facts constituting a difference between them and the Maoris of later times."

The beginning of this sentence, which I shall show in the sequel, consists of an untruth, might lead one to suppose that the so-called author has committed only an indiscretion, but when I read the résumé itself I found that

all the principal results of my excavations had been published without my permission or consent, and that thus a most flagrant breach of faith and trust had been committed.

Here are the facts of the case.

About three years ago, when examining some geological sections near the gorge of the Ashley, I found there a man of the name of A. McKay, usually working as a labourer at the flax-mills in that locality, but, having once been a gold-miner, he had been instructed to drive a gallery upon a supposed coal seam.

As this person appeared to be very fond of geology, and to have a great thirst to learn something, he was very anxious that I should take him with me on one of my journeys to look after the horses, etc., and upon his earnest solicitations I engaged him shortly afterwards for such purpose.

Returning from a journey lasting some months, during which I had found him zealous, I employed him in menial work at the museum, and sent him afterwards to collect fossils at the Waipara; during all that time I had been lending him books and doing everything in my power to help him on.

When I had collected the necessary funds for the expenses of the exploration to be undertaken in the Sumner Cave, I took him there with another working man I had engaged for the purpose, to make the necessary excavations under my own directions, and, as my report shows, superintending the work myself, generally going twice a week down to the cave to direct their proceedings in every respect.

Thus not only were all the principal discoveries, with one exception, made under my own eye, or I may say with my own hands, but all the measurements were also made by myself, and all the notes written on the spot; not trusting any one else with these matters.

When there was sufficient material collected, I took the same with me for deposition in the museum, properly labelled, and only in the last week, when great quantities of kitchen middens, both of Maori and moa-hunter origin, were obtained near the entrance of the cave, were they brought up together at the termination of the work.

As I thought I could place full confidence in the man's honesty, I explained to him always the nature of every object discovered (he did not know the difference between the bones of a bird and of a mammal), but, to give him real interest in the work, I not only spoke unreservedly before him about the results obtained, with scientific friends I took down during the time the work proceeded, but gave him also freely my views about the whole bearings of these interesting excavations, and when the work was finished, and he asked my permission to write me some notes on the same, I—taking an interest in his advancement—encouraged him to do so, which notes, three or four pages in quarto, if I remember rightly, after reading I tore up as of no value to me.

It will thus be seen that the statement in the beginning of the account given by the *New Zealand Times* is altogether devoid of truth, and only made to hide somewhat the dishonest action of filching another man's property.

I afterwards employed A. McKay to wash the specimens and varnish the bones, during which time both Mr. F. Fuller and myself gave him, unreservedly, all information upon them, and when shortly afterwards Dr. Hector came to Christchurch, I recommended the said person to him warmly as a zealous collector, upon which recommendation he was engaged to go to Wellington.

I therefore strongly protest against this most glaring breach of trust, of which no similar instance is known to me.

It deeply grieves me, that a man, for whom I have done everything in my power to help him on in the world, should thus, by betraying so shamefully the confidence placed in him, gain an unenviable notoriety, but I am still more astonished to see a person in Dr. Hector's position, actually help my former workman in this business. This is incomprehensible to me. The Director of the Colonial Museum cannot plead in excuse that he had been deceived himself by McKay, as I went to the trouble to take him myself to the cave a few weeks after the excavations had been finished, and to explain to him what had been the principal results of my excavations, towards the expenses of which I paid a fair share out of my own pocket. In one word, Dr. Hector must know that the abettor of such a perfidious transaction, is as guilty as the perpetrator himself.

NINTH MEETING. 1*st October*, 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New member.—R. Parker.

1. "On a new Thermometer for Lecture Purposes," by Professor A. W. Bickerton, F.C.S. (*Transactions*, p. 152.)

2. "On a Modification of the Electric Lamp for projecting the Spectra of different Metals on the Screen," by Professor A. W. Bickerton. (*Transactions*, p. 403.)

3. "Notes on an alleged new Species of Tern (*Sterna alba*, Potts)," by Walter L. Buller, D.Sc., F.L.S., C.M.Z.S. (*Transactions*, p. 214.)

4. "Explanation of some personal Remarks made in Mr. Potts's paper on the Birds of New Zealand, part IV., Trans. N.Z. Inst., Vol. VI.," by Julius Haast, Ph.D., F.R.S.

On page 140 of Vol. VI. of the Transactions of the New Zealand Institute, Mr. Potts reprints, from the introduction of Dr. Buller's "Birds of New

Zealand," a passage from a letter of mine having reference to two skins of the New Zealand sparrow-hawk which I received for the Canterbury Museum from Mr. W. Phillips, in order to modify the same by authority of that latter gentleman.

I have looked over the passage in question, and find that Dr. Buller, without doubt in order to make my English in the sentence referred to (which was not intended for publication) more suitable for the press, introduced a few verbal alterations. Thus, I did not write I "secured" them from the nest, but I "got" them from the nest, meaning I received them from the nest. In order that the blame, if there be any, may settle upon the right person, I wish to read here the passage from my notes, written, as it were, under the dictation of Mr. W. P. Phillips, although I may add that it is very possible that that gentleman intended the first part of his communication to be more of the nature of a surmise, whilst I took it, like the latter part, as facts observed by himself.

"Wednesday, Feb. 14.—Received two skins of the sparrow-hawk, male and female, for the museum from Mr. William Phillips, with the following important information :—He observed them regularly fly up and down little gully behind the station, where they had their nest, taking up food for their young ; finds that *Nestor notabilis* is sometimes a great nuisance, as it attacks and kills the chicks of the poultry, besides going at the meat."

It will thus be seen that I transcribed simply the first part of the above given extract in a private letter, and alluded to incidentally, and which I never thought would be printed, as otherwise I would have given credit to the gentleman from whom the information was obtained.

The honorary secretary read the following resolution, passed by the council :—

"That this council records its emphatic protest against the publication of the paper by A. McKay, on the Sumner Cave exploration undertaken by Dr. Haast, in which paper the results of Dr. Haast's investigations are appropriated and their publication forestalled, and this council requests the representative of the Philosophical Institute, W. Rolleston, Esq., to take what steps he may deem necessary to exclude it from publication in the Transactions of the Institute."

Dr. Powell said that if such things as this were allowed to be done they could not, with any degree of self-respect, remain affiliated to the New Zealand Institute. He trusted the general meeting would approve the action of the council in this matter.

It was moved by the Rev. C. Fraser, seconded by Professor Bickerton, and carried unanimously,

"That this meeting cordially approves of the resolution of the council now

read and of the action proposed to be taken in preventing the publication in the Transactions of the paper by Mr. McKay, as an attempted anticipation of Dr. Haast's paper on his own work, and that a copy of this resolution be forwarded to the several governors of the New Zealand Institute."

Mr. Fraser might say that there was no desire to say anything here against Dr. Hector, as he had not yet given any explanation of the circumstances under which McKay's paper had been read by him. It would therefore be unfair to pass judgment until such an opportunity of explanation had been given. Mr. Fraser then quoted the first paragraph of Mr. McKay's letter in reply to Dr. Haast, pointing out that it contained an evident shirking of the true question at issue.

Special Meeting. *28th October,* 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

His Honour W. Rolleston, B.A., was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act.

1. "On the Existence of two Species of *Hieracidea* in New Zealand," by Walter L. Buller, D.Sc., F.L.S. (*Transactions*, p. 213.)

2. "Description of a new Species of Petrel (*Procellaria affinis*)," by Walter L. Buller, D.Sc., F.L.S. (*Transactions*, p. 215.)

3. "On the Ornithology of New Zealand," by Walter L. Buller, D.Sc., F.L.S. (*Transactions*, p. 197.)

4. "A Scheme of University and General Education," by Professor A. W. Bickerton. (*Transactions*, p. 154.)

Annual General Meeting. *5th November,* 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

New members.—J. P. Maxwell, C.E., H. H. Loughnan, H. B. Johnstone, J. Ollivier, Thos. Douglas, W. M. Lewis.

Election of Officers for 1875.—*President*—Julius Haast, Ph.D., F.R.S.; *Vice-Presidents*—R. W. Fereday, Rev. J. W. Stack; *Council*—Dr. J. S. Coward, H. J. Tancred, Ll. Powell, M.D., G. W. Hall, His Honour Mr. Justice Gresson, Professor A. W. Bickerton, F.C.S.; *Hon. Treasurer*—John Inglis; *Hon. Secretary*—C. M. Wakefield.

Moved by Mr. C. C. Bowen, seconded by Mr. L. Walker, and carried by 8 to 7,—

"That the Philosophical Institute desires that a copy of the resolution passed on the 1st October, 1874, be forwarded to Dr. Hector, with a request

that he will be good enough to give his opinion to the Board of Governors on the matter."

ABSTRACT REPORT OF THE COUNCIL.

In presenting their annual report for the year 1874, the council beg to congratulate the members of the Institute on the fact that there has been a slight increase in the average attendance at the various meetings held during the year, and that the number of members has also increased.

The council trust, however, that with the increasing numbers of the Institute a better attendance may be secured for the future.

The Institute numbers ninety-one members, fifteen having joined during the year.

Eleven general meetings have been held, including an extra meeting on 5th December, 1873. The average attendance at these meetings was slightly over eleven.

At these meetings nineteen papers have been read.

During the present year a paper "On the Geodephagous Coleoptera of New Zealand," in which many new species are described, has been published by H. W. Bates, F.L.S., in the Annals and Magazine of Natural History (ser. 4, vol. xiii., 1874), with the express intention of assisting the entomologists of New Zealand. The council take this opportunity of thanking Mr. Bates for his valuable contribution to the natural history of this colony, and also of requesting the Board of Governors to reprint the paper in the next volume of the Transactions.

The Council regret that they have not been able to carry out the resolution passed at a meeting of the Institute with regard to the writing of a "History of Canterbury," Mr. W. M. Maskell, the proposed author, having relinquished the undertaking, and no other member being willing to supply his place.

An arrangement has been entered into with the Public Library Committee, whereby the Institute are to retain the use of the rooms they at present occupy, rent free, upon condition of placing their books and periodicals in the public library, such arrangement to be terminable by three months' notice on either side.

SPECIAL GENERAL MEETING. *26th November*, 1874.

R. W. Fereday, Vice-president, in the chair.

"On the Course of University Education," by the Rev. C. Fraser, M.A. (*Transactions*, p. 164.)

Special General Meeting. *23rd December*, 1874.

Julius Haast, Ph.D., F.R.S., President, in the chair.

1. "Notes on the Word Moa in the 'Poetry of the New Zealanders,' compiled by Sir George Grey, K.C.B.," by the Rev. J. W. Stack. (*Appendix.*)

2. "A brief Sketch of the Several Maori Occupations of the South Island," by the Rev. J. W. Stack.

3. "On a simple Telegraph Code, by a Modification of the Morse Instruments," by Professor A. W. Bickerton.

4. "On the Genus *Himantopus* in New Zealand," by W. L. Buller, D.Sc., F.L.S. (*Transactions*, p. 220.)

5. "Notice of a new Species of Parrakeet in New Zealand," by W. L. Buller, D.Sc., F.L.S. (*Transactions*, p. 219.)

6. "Notes on an ancient Native Burial Ground near the Moa-bone Point, Sumner," by Julius Haast, Ph.D., F.R.S. (*Transactions*, p. 86.)

7. "Notes on the Moa-hunter Encampment at Shag Point, Otago," by Julius Haast, Ph.D., F.R.S. (*Transactions*, p. 91.)

Special General Meeting. *5th January*, 1875.

Julius Haast, Ph.D., F.R.S., President, in the chair.

The honorary secretary read two letters from Dr. Hector, dated Wellington, 22nd December, 1874, together with various documents referring to the paper by Mr. McKay.*

Dr. Haast read the following protest :—

"The minutes of the Board of Governors of the New Zealand Institute, of 21st December, I cannot let pass without entering my protest against the mode in which it glosses over the breach of faith committed by my former subordinate in publishing discoveries made by me. Resolution No. 2 talks of the paper as if its subject were not the Sumner Moa-bone Cave, but as if it were a revision of the old theories on the subject of moas previous to the excavation of that cave. It ignores the fact that the paper could not have been written, had I not gone to the trouble of exploring the Sumner Cave. The paper read has no significance unless it were founded on the excavations conducted under my superintendence, and for a servant to publish or make use of in any way the discoveries made under guidance of his master, has always been considered a breach of honour and faith by all scientific bodies. Hence my surprise that a body officially representing the science of New

* *Vide post.*

Zealand should publish without comment of its own a paper founded upon information which, according to all precedent, was not the property of the person who contributed it.

(Signed) "JULIUS HAAST.

"5th January, 1875."

Moved by his Honour W. Rolleston, seconded by Mr. G. W. Hall, and carried unanimously,—

1. "That this Institute does not wish to pursue further the consideration of the course taken by the Board of Governors in respect to Mr. McKay's paper, but desire to obtain an authoritative opinion on the general question, how far scientific matter collected by a person employed to collect the same is the property of the person who employs the collector."

2. "That the council be requested to prepare an accurate statement of the case, the decision of which would determine the principle which should guide the present and similar cases; that the case so stated should, after being laid before the Institute, be submitted to such independent authority as may be deemed fit."

Dr. Haast tendered his resignation as President, but withdrew it at the unanimous request of the meeting.

EXTRACT FROM THE MINUTES OF A MEETING OF THE BOARD OF GOVERNORS OF THE NEW ZEALAND INSTITUTE, HELD 21ST DECEMBER, 1874.

The Board having had under consideration the following documents :—

A.—Protest by Dr. Haast against the publication of a paper, by Mr. Alexander McKay, on the Moa-bone Cave at Sumner.

B.—Resolutions by the Philosophical Institute of Canterbury, of the same nature.

C.—Memorandum by the Manager of the New Zealand Institute on the subject.

D.—Explanation by Mr. Alexander McKay.

E.—Postscript to a paper, by Dr. Haast, on the Moa-bone Cave at Sumner.

F.—Mr. McKay's reply thereto.

Resolved:—

1. That the paper by Mr. McKay having been forwarded in due course to the Board by one of the Affiliated Societies for publication in the Transactions, the Board can only consider the question of its publication on the same footing as that of papers generally submitted by Affiliated Societies, the Board having no power to deal with the question raised by the Canterbury Philosophical Society in the manner suggested in the communication made by the honorary secretary of that society, under date 6th October last.

2. That, moreover, as it appears from the report of Dr. Hector that the paper by Mr. McKay contains views different from those held by Dr. Haast on a subject of general interest which has already been frequently discussed by members of the Institute, as appears from the Transactions already published, the Board is of opinion that it is desirable that both papers should appear in the Transactions for the current year.

3. That the several documents submitted to the Board in connection with the question raised by the Philosophical Institute of Canterbury should be published in the Proceedings.

4. That a copy of these resolutions be forwarded by the Manager to the Philosophical Institute of Canterbury, together with a copy of his memorandum and the explanation of Mr. McKay.

A.

Telegram.

Waimate 14·12·74.

To the Chairman Govrs. N. Zealand Institute, Wellington.

I protest against the publication in the Transactions of proceeding of A. McKay's paper in which the principal result of my excavations in the Moa-bone Point Cave are contained and my own publications forestalled he having obtained knowledge of the facts as my paid servant and having used the same without my knowledge or consent.

Julius Haast
President Philosophical Institute
Canterbury.

B.

Resolution by the Philosophical Institute of Canterbury, passed 5th November, 1874. (See pp. 532–3.)

Two resolutions, passed by the Council of the Philosophical Institute of Canterbury on 1st October, 1874. (See pp. 531–2.)

C.

Memorandum for the Board of Governors of the New Zealand Institute.

At the request of the Canterbury Philosophical Institute I submit certain resolutions of that society, protesting against the publication of the paper by Mr. Alexander McKay on the Sumner Cave, also, a protest by Dr. Haast, of the same nature, addressed to the Chairman of the Board (A), and I beg to offer the following opinion thereon :—

In April last Mr. McKay, who was then in the employment of the Geological Survey Department, showed me the paper in question, and, seeing that it contained views founded on his own observations, I noted it for communication to the Wellington Philosophical Society, of which he was elected member in July, before the paper was read. Had I acted otherwise, by advising the suppression of the paper, I consider that I should have been presuming on my official relations with Mr. McKay.

I saw no reason for taking such a course, and the paper was put down for reading by the council of the society, but, owing to pressure of other business, was not actually read till 8th August. During the interval the title was repeatedly advertised in the newspapers.

On receiving the protest from the Canterbury Philosophical Institute, I applied to Mr. McKay for an explanation of the circumstances, and I now lay the reply before the Board (D).

I have also carefully compared the two papers, and advise the Board that the protest by Dr. Haast should be disallowed, and that the Canterbury Philosophical Institute should be informed that their resolutions of 1st October, 1874, are founded on an erroneous conception of Mr. McKay's paper, which they had not seen when the resolutions were passed. I recommend this course for the following reasons :—

1. Mr. McKay's paper is not yet published for circulation, but Dr. Haast has issued his paper as a pamphlet, and thereby effectually secured himself from being forestalled.

2. Dr. Haast has refused to submit his paper to the Board, the secretary of the Canterbury Philosophical Institute telegraphing, in answer to my request for the paper, that Dr. Haast retains it until the decision of the Board is known. I have, therefore, had to form my opinion of it from an unauthorised copy, which differs from the paper as read to the society in the suppression of a postscript which appeared in the public press.

3. The portion of the paper now suppressed is of an offensive nature, and is an attempt to disparage the character and discourage the efforts of a member of another affiliated society.

4. From consideration of the two papers I find that the writers arrive at different conclusions respecting an ethnological question which has already been discussed in papers before several of the affiliated societies.

5. Mr. McKay does not attempt to give any detailed description of the discoveries made while he was employed by Dr. Haast, giving only such a general outline as is necessary to make his views intelligible until his former employer should divulge the result of the explorations.

18·12·74. James Hector.

D.

Wellington, 26th November, 1874.

To Dr. Hector, F.R.S.

I was first employed by Dr. Haast during the summer of 1871-2, and accompanied him while examining the Clent Hill and Shag Point districts on account of the Geological Survey of New Zealand, during which time he frequently commended me on account of my attainments in geology.

On the conclusion of these surveys Dr. Haast next sent me to make collections from the Saurian beds in the Middle Waipara and Heathstock districts, in which work I acquitted myself much to his satisfaction, bringing, as I did, a large and valuable collection of Saurian and other fossil remains to the Canterbury Museum.

Having arranged these collections as they now are in the Canterbury Museum, I was employed during the remainder of the winter in washing and varnishing the large collection of moa remains then recently obtained from Glenmark.

I had already made myself acquainted with Dr. Haast's views respecting the extinction of the moa, as described in his paper on the Rakaia moa-hunter deposits, and during some conversation concerning his views as expressed in his paper "On Moas and Moa-hunters," he mentioned the Sumner Cave as being a locality from which he expected further confirmation of his views as then held, and that as soon as he had collected the necessary funds he would employ me to do the work for him. By the 1st October, 1872, sufficient funds were collected wherewith to begin the work, and I was directed to engage another man to assist me in making the excavations required. Having done so, and conveyed every requisite to the cave, Dr. Haast arrived at the cave a few hours later to give directions as to the method to be pursued during the progress of the works contemplated. I was directed to ticket all articles worth preserving, noting the particular stratum or bed whence they were obtained. This I did for the first two or three days, but on Dr. Haast again visiting us, deeming this process rather too slow, he directed all material preserved to be laid aside, according to the natural subdivisions of the deposit. Complying with these instructions, I laid aside all finds not ticketed, but in three lots—upper, middle, and lower. Dr. Haast, visiting the cave as a rule generally twice a week, removed the collections in this unticketed state (I am sorry to observe that in the postscript to his paper on the cave Dr. Haast says that he removed the collections properly ticketed. I am compelled to deny the statement there made)—with the exception of one day's work, during which Mr. Fuller and himself were with us the whole day. With the above exception his visits seldom lasted more than two hours on any occasion, and thus it will be seen that he could not possibly "direct our proceedings in every respect."

When the work was finished, and everything removed to Christchurch, by his orders I attended at his study so as to supply him with what notes I had collected, at which time I supplied him with the report mentioned in the postscript to his paper, besides answering many questions relative to the disposition of the several beds and their contents. I told him that there could be no doubt but that the whole evidence proved that the moa-hunters possessed polished stone axes and other tools and ornaments. He replied, rather hotly, that he had no personal views to uphold, and that his object was truth. I was next employed to wash, varnish, and ticket the specimens according as found, either in lower, middle, or upper beds, which I accordingly did, and placed them in an exhibit case in the museum, where they remained for at least twelve months ticketed in my handwriting.

Since then I expected that he would supply a report on the Moa-bone Cave. But as time went on I foresaw that no paper was likely to appear, which led me to think of adding my views to the original report I supplied Dr. Haast with, and getting it read before a society.

Mr. Fuller could prove that the idea had occurred to me twelve months before the reading of my paper, that if Dr. Haast did not read a paper on the subject I would do so, though how I should manage it had not occurred to me.

When I gave you the paper for publication I had no intention of attemping to forestall Dr. Haast, or to do anything but make known what I knew about the cave, firmly believing, as I did, that Dr. Haast had no intention of publishing anything on the subject.

I have the honour to be,
Sir,
Your obedient servant,
Alex. McKay.

E.

Postscript to a Paper, by Dr. Haast, "On the Moa-bone Cave at Sumner." (See pp. 528–530.)

F.

To the Editor of the *New Zealand Times.*

Wellington, 26th September, 1874.

Sir,—In to-day's issue of your paper you print, in a prominent position, a postscript to a paper recently read by Dr. Haast before the Canterbury Philosophical Institute on the Moa-bone Cave at Sumner. This postscript is devoted almost entirely to my vilification, on account of my having presumed to write a paper on a subject which Dr. Haast seems to consider peculiarly his own. He charges me with dishonest conduct, and includes Dr. Hector in the charge as my aider and abettor.

I hope that, as this charge appears in your columns, you will give me an opportunity of refuting it, not only as regards myself, but also the Director of the Geological Survey, who is at present away from Wellington.

Dr. Hector's connection with the affair extends no further than that, as a personal favour, he read my paper on the Sumner Cave before the Philosophical Society—a favour which he is in the habit of extending to many more besides myself, as the minutes of the society show.

Dr. Haast will therefore, I hope, see fit to withdraw the last paragraph of his remarkable paper, in which he charges Dr. Hector with being the wilful abettor of my alleged dishonesty.

With respect to Dr. Haast's somewhat ungentlemanly comments on myself, and his assertion that I have dishonestly betrayed a trust reposed in me, I fail to see wherein I merit the one or am guilty of the other. Dr. Haast says that the works were entirely conducted under his own superintendence. This is scarcely true; nevertheless, I will, for the sake of argument, accept it as truth, and regard myself in the light of a mere mullock-turning machine, examined and cleaned at stated intervals.

These, then, being expressly the conditions under which I was employed, I cannot see that Dr. Haast has any claim to any facts or theories I might observe or entertain on matters which, by his own showing, were quite outside my especial duties. Dr. Haast says that he explained to me the nature of every object discovered, and that he found me incompetent to distinguish between the bones of a mammal and a bird. In answer to this, I will only say that some months previous to the exploration of the Sumner Cave I was employed by Dr. Haast in searching for moa bones in Shag Valley, and, as bullock bones are plentifully scattered about in that locality, I hope, for Dr. Haast's reputation, that he has not sent to foreign museums, as moa bones, any of the collections which I then made for him. If I was incompetent to distinguish a mammal from a bird bone, why did he employ me on this work? I leave him to answer.

I may say that I have myself known Dr. Haast to be in error in judging on points of comparative anatomy; but any anatomist is liable to error, and I do not wish to bring before the public every triviality which occurs to my memory regarding him. My original motive in writing my paper on the Sumner Cave was to give to the world the theoretical bearings of the facts collected by me on his previously published theories respecting the extinction of the moa by a race which he regarded as distinct from the Maoris. His views on this subject are given in the Transactions of the New Zealand Institute, Vol. IV., art. 4. If I filched notions from him at all, that published paper—and not, as he says, verbal instruction received from him—was the source of my information.

The Sumner Cave explorations were made two years ago, since which Dr. Haast has had plenty of time to publish his views, and it is my belief that but for the above paper by me the public would not have had any communication from Dr. Haast for a long time to come, as the facts collected conflicted so strongly with his pet theories respecting moas and moa-hunters.

As to Dr. Haast's encouragement of my leaning to science, and the notes, consisting of "three or four pages in quarto," which, "after reading, he tore up as of no value to him," I may say that, fortunately, I only gave to Dr. Haast a copy of my original notes, which are contained in a notebook now in my possession. Such treatment of one's efforts is truly encouraging.

Dr. Haast labours hard to show what my antecedents were, but has shown nothing relative to me of which I need be ashamed. It is true that while in Dr. Haast's employment I was engaged in menial occupations; but I cannot see why, not having had the superior advantages of education which Dr. Haast seems to have enjoyed, I should be subject to his sneers because I try to raise myself to a higher position in the intellectual world.

Begging excuse for trespassing at such length on your valuable space,—I am, etc.,

Alex. McKay.

OTAGO INSTITUTE.

SECOND MEETING. *28th May*, 1874.

J. T. Thomson, F.R.G.S., President, in the chair.

Mr. Thomas Kirk, of Wellington, spoke in terms of commendation of Mr. G. Thomson's paper on the Naturalized Plants of Otago,* which he would have been glad to see more complete, as the list given by the author could scarcely be considered to comprise more than a third of the species already established in the province. Amongst the plants named he observed one or two species, as *Bartsia viscosa*, etc., not yet collected in other parts of the colony, and the mode of introduction of which it seemed specially desirable to ascertain if possible, as they were plants of local distribution in Europe, and of a character differing widely from the usual naturalized plants in this colony. He regretted to notice that the author had failed to discriminate between such plants as *Bellis hypocharis* and other species undoubtedly introduced, and such as *Geranium molle, Polygonum aviculare*, etc., which must be held to be indigenous, although their area had been extended by introduction. The greater vigour and consequent rapid increase and abundance of the plants grown from introduced seed at once attracted notice, and in cases of this kind led to the very common error of considering truly indigenous, but naturally unobtrusive, species to have had a foreign origin. He hoped the paper would be followed by others on the same subject, and would suggest that the author might advantageously present specimens of all naturalized plants observed by him to the herbarium of the Otago Museum. This would afford the opportunity of correcting any errors that might occur in nomenclature, from the want of familiarity with exotic plants, in not a few cases of a critical character. Mr. Kirk made some observations on the chief points of difference between the floras of Auckland and Otago.

1. "Critical Notes on Dr. Buller's Birds of New Zealand," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, Vol. VI., 1874, p. 126.)

2. "Notes on the New Zealand Hydroideæ," by Dr. Millen Coughtrey. (*Transactions*, p. 281.)

Captain Hutton agreed with Dr. Coughtrey that *Sertularia subpinnata*, Hutt., was but a variety of *Sertularia johnstoni*, Gray, and also that the New

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* Read 7th April. See Transactions, p. 370.

Zealand *Thuiaria* differed sufficiently from *T. articulata* to warrant its being made into a separate species, as Dr. Coughtrey proposed.

3. "Notes on Rare Ferns," by P. Thomson.

The two mounted ferns on the table were discovered by Mr. Purdie and myself during a walking tour we made to some of the southern districts of the province during the month of March last. They are believed to be new to the district, or at least have never been described before.

The first one is a *Lomaria*, and was found growing among *L. banksii*, but differs from it in several particulars. The locality was a small rocky bay not far from the Nuggets, and the plants were growing almost within reach of the breakers at high water. It is to be regretted that neither of us were provided with anything for the safe carrying of botanical specimens, having left our usual impedimenta behind at the hotel at Port Molyneux, in order to lighten the walk along the beach. The specimens had consequently to be crammed into a bag, by which they were mostly a little damaged.

The fern above spoken of has been since determined to be *Lomaria dura.* The circumstance is very interesting, as the fern has not hitherto been found on the mainland, but was supposed to be entirely confined to the Chatham Islands.

The second specimen is evidently an *Alsophila*, resembling *A. colensoi.* It was gathered in a patch of bush on the north side of the river Puerua, not far from the residence of the Hon. Major Richardson, at Willowmead. It was growing in a rather densely crowded spot, the trees high overhead and close undergrowth. The fronds of the plant from which the specimen was taken were about four feet long, but the stem was short.

Since then Mr. Purdie has discovered another variety of *Alsophila*, which differs from the other in having the pinnæ forked or branched. From the midrib of the frond proceeds a short stem, which immediately divides into two pinnæ radiating from each other at a considerable angle, and, as the pinnæ are opposite, the variety is a very beautiful one indeed. The locality where this *Alsophila* was discovered is a small clearing near the top of Pine Hill, Dunedin.

Mr. Kirk remarked that although the ferns named could not be considered in any way new, yet the occurrence of *Lomaria dura* in the South Island was of great interest. Previously it had only been known as a native of the Chatham Islands, where it was first discovered by Archdeacon W. L. Williams about ten or eleven years ago, and subsequently collected by Captain Gilbert Mair, and afterwards by Mr. Henry Travers in his investigation of the flora and fauna of those groups. The structure of the fertile frond approached close to *L. banksii*, but it was of much greater size, while the barren fronds closely resembled those of *L. discolor.* The *Alsophila* was simply a fern with

narrower pinnæ than usual; the ordinary fern had been discovered in the vicinity of Dunedin many years ago.

THIRD MEETING. 11*th June*, 1874.

J. T. Thomson, F.R.G.S., President, in the chair.

1. "Preliminary Remarks on some Birds of New Zealand," by Otto Finsch, Ph.D., of Bremen, Hon.Mem.N.Z.I. (*Transactions*, p. 226.)

Captain Hutton, who read this paper, said that the correction in the systematic position of many of our birds was of very great importance. The paper was but a forerunner of a small book on the birds of New Zealand which Dr. Finsch would shortly publish. This book was to be called, "Synopsis of the Birds of New Zealand"; it would be printed in English, and its cost would be about ten shillings.

2. "Notes on the reported Collision of Biela's Comet with the Earth's Atmosphere," by Henry Skey. (*Transactions*, p. 148.)

The President said that his observations on the Comet of 1843 had led him to suppose that comets were ellipsoids of matter, the nucleus of which was alone visible under ordinary circumstances, but that the portion called the tail was rendered luminous by the diffraction of the light of the sun by the margin of the nucleus. This accounted for the tail always being directed away from the sun, while the ellipsoidal shape of the comet was the cause of the contraction of the tail as it approached the sun, and its lengthening again when it receded from it.

Mr. Peter Thomson exhibited some Ferns found by the Field Naturalist Club in the neighbourhood of Dunedin.

Captain Hutton exhibited Paper Pulp made from the red tussock grass, presented to the Museum by Mr. E. M'Glashan.

FOURTH MEETING. 13*th July*, 1874.

J. T. Thomson, F.R.G.S., President, in the chair.

New members.—Vincent Pyke, —. Malcolm.

1. "Description of some Moa Remains from the Knobby Ranges," by Captain F. W. Hutton, F.G.S., with Anatomical Notes, by Dr. Millen Coughtrey. (*Transactions*, p. 266.)

In the discussion that followed it was suggested that the preservation of the skin and tendons was due either to the dryness of the climate, or to some antiseptic property in the soil.

2. "Description of some Plates of Baleen in the Otago Museum," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, p. 266.)

3. A letter from Dr. Gray, of the British Museum, was read, noticing the finner whale that was caught off Otago Heads last October, which he stated was closely allied to the pike whale (*Balænoptera rostrata*) of the north.

Captain Hutton exhibited the skull of a whale, probably *Mesoplodon longirostris*, Krefft, that came ashore in Blueskin Bay.

Dr. Coughtrey thought that the southern position of Otago made it a very advantageous position for establishing a whaling station. From his experience in the north of Scotland, he could say that whaling was a very profitable undertaking. He had known a profit of £800 made out of a whale, and it was very common to make £500. South Sea whalebone had obtained a very bad name at Home, but he was sure that the Baleen exhibited that evening (*Balænoptera sibaldii?*) was of a very superior quality. Dr. Gray stated that the whalebone of *Neobalæna marginata* was the finest in the world, but, unfortunately, it appeared never to attain a large size. If the seas were explored near the margins of the ice-field, it was probable that a species very similar to the right whale of the arctic seas might be found.

Fifth Meeting. 15*th July*, 1874.

J. T. Thomson, F.R.G.S., President, in the chair.

New members.—Dr. H. Sorley, Professor Coughtrey, Dr. W. Brown, R. McNaughton.

1. "On the Zodiacal Light as seen in Southern Latitudes," by W. Skey. *Transactions*, p. 150.)

2. "Notice of the Earnscleugh Cave," by Captain F. W. Hutton, F.G.S. ; with remarks on some of the more remarkable Moa remains found in it, by Professor Millen Coughtrey. (*Transactions*, p. 138.)

Mr. Gillies said that it would seem that after all they were going to have the moa as a contemporary. There were many of the old settlers whose statements in reference to this matter he thought might be of value.

The President also thought that the statements of the old settlers in reference to this matter should be obtained. He remembered eighteen years ago, when at Mataura, observing a large number of moa bones there. These had since completely disappeared. This led him to believe that eighteen years previous to that time the bones of the moa must have been very plentiful there, and that consequently the existence of the bird itself could not date very far back. He thought they should get some record of these things before all the old rs would have passed away.

Captain Hutton pointed out that the principal items of interest in the matter were contained in the fact of rats having been found buried in the cave in such a position as to lead to the belief that they were contemporaries of the birds found mixed up with those of the moa in the cave. Had the matter been new to him he would have thought the evidence conclusive that the moa, rats, and ducks had lived together. He thought it probable that the remains of the rats found were those of the brown rat introduced by the Europeans, as it was known that the black rat introduced by the Maoris did not feed upon flesh; and he therefore did not think the bones found in the cave could have been gnawed by that species. Altogether, he considered the evidence supplied by this cave the strongest yet adduced in support of the belief that the extinction of the moa was but of recent date.

3. "Description of a new Species of *Actinia* (*A. thompsoni*)," by Professor M. Coughtrey. (*Transactions*, p. 280.)

4. "Descriptions of two new Species of *Aplysia*," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, p. 279.)

Sixth Meeting. 10*th August*, 1874.

James M'Kerrow in the chair.

New members.—Dr. Cole, W. Conyers, G. Miller, H. F. Hardy.

1. "The Mythology and Traditions of the Maori in New Zealand, Part II.," by the Rev. J. F. H. Wohlers. (*Transactions*, pp. 15 and 41.)

2. "On some common Causes of Consumption in Otago," by Robert H. Bakewell, M.D.

The author classed his subject under three heads:—1. The breathing of impure air; 2. Mental depression; 3. Over education or "cram." He referred to the great want of proper ventilation in the majority of houses and schools in Dunedin, and gave some interesting particulars.

The chairman remarked that the members had heard a very able and practical paper, and suggested that some observations upon it would be desirable.

Mr. Johnston said that with regard to "cram," he would ask the lecturer what he considered a fair day's work for a child?

Dr. Bakewell replied that much would depend upon the previous health and constitution of the child; there could be no fixed rule for it.

Mr. Johnston fully agreed with the lecturer that some steps should be taken to prevent children being crammed with excessive learning, and also to secure proper ventilation.

Mr. Stout was not prepared to deal with the medical part of the paper,

but thought more attention should be given to the subject of ventilation. As to cramming children, after all he had heard about it he scarcely understood what "cram" was. It would be impossible to carry out an educational system without the so-called "cram." Only about five hours were spent in school daily by the children.

Mr. R. Gillies thought their thanks were due to Dr. Bakewell for having directed their attention to the want of ventilation in the public schools. None of the schools were properly ventilated, except the High School, and in consequence some parents were reluctant to send their children. He was sorry that Dr. Bakewell had not touched upon a most important question—is consumption so prevalent in Otago? The causes mentioned by the lecturer were not peculiar to Otago.

Dr. Bakewell did not intend the whole of his remarks to refer especially to Otago, though there was one peculiarity which he had never seen in other places—the windows not opening at the top.

Mr. Hawthorne, after thanking the lecturer for his excellent paper, said that he did not believe in over-cramming the young people. During the whole of his experience in the other colonies he had never seen so little provision made for the physical education of children as in Otago. He had been informed by more than one parent that it was no unusual thing for the children to be carried out of the Middle District School in a fainting state on account of the atmosphere. He described the state of the children and teachers during one of his visits to the Middle School. With the exception of the North School, there was not a decent play-ground, or one worthy of the name. Mr. Hawthorne referred to the new school to be erected in Moray Place, which will provide accommodation for 1000 children, and only have thirty feet square as a play-ground.

Mr. Stout did not think the play-grounds were of so much importance as was suggested.

Seventh Meeting. 12*th October*, 1874.

R. Gillies in the chair.

1. "Observations on the different Modifications in the Capsules of Mosses, with reference to the Dispersion of their Spores," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, p. 342.)

2. "On the Dimensions of *Dinornis* bones," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, p. 274.)

3. "Description of the Moa Swamp at Hamilton," by B. S. Booth; communicated by Captain Hutton. (*Transactions*, p. 123.)

Mr. Murison said however they might disagree with the theories that had

been advanced by Mr. Booth in his paper, there could be no doubt that the information which it contained was a valuable contribution to the records of the Institute. The paper was valuable, because it embodied the independent observations of an intelligent man, who seems to have devoted a good deal of time and thought to the investigation of this bone deposit. Mr. Booth's primary object in preparing his paper was to describe, according to his own ideas, the manner in which these bones had come to be deposited in the swamp at Hamilton; but there arose out of his deductions on this subject the larger question of the date of the existence of the moa. Mr. Booth concluded that the bird became extinct several thousand years ago, and his conclusions, therefore, were not altogether dissimilar to those of Dr. Haast, although that gentleman fixed the date of the extinction of the moa at somewhere about five hundred years back.

Captain Hutton: Three thousand years ago is the time, I think, fixed by Dr. Haast.

Mr. Murison pointed out that the evidence upon which Dr. Haast, Mr. Booth, and others rested their theory of the moa having become extinct at a very remote period was altogether of a negative character. It was quite true that the bird had lived in these remote ages, but the positive evidence which many of the settlers, in this province at least, were able to bring forward, went to show that the moa lived within the last hundred years, and probably within the present century. The discoveries of moa remains on the Maniototo plains, in his opinion, established beyond all doubt the fact of the comparatively recent existence of the moa. On the banks of the Puketoitoi creek, some years ago, were found on the surface of the ground bones in a tolerably perfect state of preservation; and when it is borne in mind how rapidly the bones of stock on the runs become decayed through the action of the atmosphere, this circumstance of the presence of the moa bones on the surface goes a long way towards proving that the bird existed in recent times. In the same neighbourhood, moreover, valuable confirmatory evidence of this theory was obtained in the kitchen middens and ovens of the moa-hunters. An examination of these showed that these people used both rude chert and polished stone implements—a circumstance which, if acknowledged, at once upsets Dr. Haast's theory of a palæolithic age in which the moas and moa-hunters lived, and in which rough stone implements only were used by the latter; and a neolithic period, or age in which polished implements were used; the latter period dating from a time long anterior to the arrival of Europeans in the islands. Mr. Booth's paper, although somewhat lengthy, was the representative of a class of contributions which he would gladly see presented more frequently to the Institute. There could be no doubt that a feeling had got abroad that, in order to produce a paper which would prove acceptable to the

Institute, a great deal of trouble would have to be taken by the writer in the preparation of his paper. This feeling deterred many who could supply valuable information from contributing the result of their observations. It could not be too widely made known throughout the province that the Institute was prepared to receive statements of facts not only concerning the subject which had been dealt with in the paper just read, but regarding natural history objects and other matters of interest. The time would undoubtedly come when the observations of the early settlers of the province, however meagre and apparently unimportant at present, would be regarded as of great value by scientific men. He hoped, therefore, soon to hear of many of the up-country settlers following the example of Mr. Booth.

Captain Hutton fully endorsed the remarks made by Mr. Murison as to the great value of Mr. Booth's paper. He would be very glad to see other papers written in the same style. The question of the extinction of the moa was one thing, and the time it had lived was another. At the previous meeting he had brought forward a paper to show that the moa had lived in the present century, but how far back it lived was quite another question. He might say that it had existed in New Zealand ever since it had been an island. He should not be at all surprised in the brown coal series to come across the bones of birds from which the moa had proceeded. He did not agree with Mr. Booth's theories, and thought they would not bear much investigation. In the first place, the difference of climate contended for could not be greater than Hamilton as it is now and the sea-coast. He (Captain Hutton) thought that would not be sufficient to warrant Mr. Booth's assumption. Secondly, Mr. Booth seemed to lay great stress upon the question as to the moa not being able to hatch its eggs. He (Captain Hutton) thought that was a mistake, and referred to what history had stated of the ostrich not hatching its eggs. If he had time he would be able to show that Mr. Booth's argument, that there were no moas since the Lake period, had but little foundation. With regard to the absence of egg shells, that was a remarkable fact; but there were numbers of bones of little chicks or birds, not certainly more than a year old. He could say that he had seen Glenmark on the Canterbury plains, but would not say much about it, for fear he might get into a row. (Laughter.) The bones were only found round springs similar to that at Hamilton. He was not going to start any theory, but he freely acknowledged the good sense which Mr. Booth had brought to bear upon the question.

Mr. Thomson wished to know if the moa bones were diseased, and whether the cold caused such a disease.

Captain Hutton quite forgot that. Many toe bones were diseased, but Dr. Coughtrey and Dr. Hocken had found that the other bones were not so. Dr. Black had also shown that the Hamilton spring was not poisonous nor thermal.

Dr. Cole said that he would suggest one theory, but perhaps it would not hold water. He could not ascertain the fact why these birds should congregate round a spring, without it was a natural instinct that they should seek water when they felt they were about to die. It was, perhaps, rather an imbecile theory, but it occurred to his mind at the moment.

Mr. J. S. Webb thought most of the members would agree with him that Mr. Booth's paper was more interesting than a moa skeleton even. The remarks of Mr. Booth with regard to the presence of snow and frost, and the birds' preference to spring water, clearly showed that there was something in his arguments. The severe and sudden storms which those present had witnessed that day, would drive birds to that particular spot mentioned to get free from cold. That argument was most ingenious.

The chairman said that he must add his quota of praise to the paper, and expressed his delight upon reading it. Though he did not agree with Mr. Booth's conclusions, he was much pleased at the paper having been brought before the Institute. He agreed with Mantell, that the time had not yet arrived to say when the moa became extinct. Had Mr. Booth been better acquainted with what had been done previously, he would have saved himself a deal of trouble. A large portion of his paper went to prove that the moa lived a great many centuries ago. No one doubted that. The real question was—had it come down to modern times? They had a very important fact, that the Maoris—all those who were competent to give an opinion—said they had no tradition whatever on the subject. (Voices: No, no.) He said it on the authority of Mantell, Sir George Grey, and others. The word moa seemed to show that the Maoris had known something of the bird. But that word moa was used in a great many different senses. Therefore, that word being in the language was no proof that the Maoris knew anything of the moa. They said it used to be hunted, but the fact he wished to point out was that the Maoris had no knowledge of the moa. So far as his opinion went, he inclined to the modern theory. There was this in its character, that the moa bones had been found with human bones, and that the former appeared to have been used as food. They had in the museum a leg with some of the flesh, sinews, and so on. He believed they would not get half-a-dozen of the old residents of Otago who thought that the moa had not existed recently. Large numbers of bones had been found on the surface of the ground, in grassy country, and on the plains. Mr. Booth would have to prove that the country had been much warmer, that the place referred to was a spring, and that the moa birds were unable to rear their offspring. If any of these theories were not proved, the arguments in their favour would tumble to the ground. Mr. Booth stated that the bones were all trampled firmly in and not broken. How would they, then, account for the bones having been entire? The time had not

come to explain this thing, and they must have more patience before they could generalize upon the subject.

Mr. Heale, of Auckland, said the observation that there were no Maori traditions of the moa was most amusing to him. If the moa had been scarce they would have been mentioned in the traditions of the Maoris. He said that if we were to pass away there would be nothing mentioned in our history about sheep, and he argued that moas stood in nearly the same relation to the Maori. The Maoris' reference to the moas in their songs and conversation was, to his idea, a stronger illustration than if the moas had been mentioned in their traditions.

The chairman remarked that Colenso was another authority he forgot to mention. It seemed to be very clear that the moas were more plentiful here than in the North Island. Their bones were very numerous on the Tokomairiro and other plains some time ago.

Captain Hutton said that Sir George Grey had informed him that there was only one place to the north of Auckland where moa bones had been found—that was the mainland just opposite the island of Kawau.

Mr. P. Thomson had some experience in collecting moa bones in a cave at Saddle Hill, and it was yet full. The settlers, however, had taken most of the large bones away. He agreed with Mr. Booth's theory with regard to the springs.

4. The President read the following letter, from Mr. W. H. S. Roberts, with regard to the Moa :—

"I came to Otago, overland from Nelson, in May, 1856, and, notwithstanding my making a point of enquiring, both of Maoris and whites, could hear of no one who had ever seen a Moa. The Maoris could describe them very well, but it was from hearsay. They stated that they formerly used the Moa as food, and used to catch them by placing flax running nooses across their tracks—for they used to have regular beaten paths, like sheep tracks. Several Maoris told me that they were purposely destroyed because they used to steal their children. A day was fixed upon, and fires were lighted in every available spot throughout the island—from north to south, and from east to west. The Moa having no wings could not escape through the long grass, and were consequently destroyed. It was at that time also that so many thousands of acres of the native forests were destroyed, the charred remains of which are frequently found by new settlers in places now quite devoid of growing trees.

"The Moa was a very swift bird on foot, and could outrun a horse easily, its miniature wings assisting it considerably. I was frequently shown bones in very good state of preservation, the length and size of them being to me matter of astonishment. At Moeraki I was informed that Mr. Mantell had procured some of the feathers, and some bones with the sinews or flesh still

adhering to them. The Maoris also spoke of a cave near Moeraki, and another near Saddle Hill, where a number of bones could be procured, but I never saw either cave.

"When I came down, in 1856, the Moa was nearly as much a bird of the past as it is now, and settlers spoke of the chance of seeing one as very improbable; at the same time wishing they could, as if they succeeded in capturing one they would have considered their fortune made. Eighteen years have passed since then, and no sign of one has been seen, and every year the weather-beaten bones are becoming fewer and fewer, yet, from their peculiar structure, should a small piece by any accident be stumbled upon it is easily distinguished from the hollow marrow bones of the horse or ox."

5. "Comparison of the Marine Mollusca of South Australia with those of New Zealand," by W. Beddnal; communicated by Captain Hutton.

The author shows that, as far as our present knowledge extends, thirty-five species are common to New Zealand and South Australia; sixty-five species common to New Zealand and New South Wales; twenty-eight species common to New Zealand and Tasmania; seventy-five species common to South Australia and Tasmania, and ninety-nine species common to South Australia and New South Wales.

6. "Descriptions of three new Tertiary Shells in the Otago Museum," by Captain F. W. Hutton, F.G.S. (*Transactions*, p. 458.)

7. "Descriptions of two new species of *Aplysia*," by Captain F. W. Hutton, C.M.Z.S. (*Transactions*, p. 279.)

Annual General Meeting. 1*st February*, 1875.

J. T. Thomson, F.R.G.S., President, in the chair.

New members.—Dr. W. Brown, Palmerston, Thos. Dick, Ed. Menlove, Oamaru, L. O. Beal, John Roberts, Duncan McKellar, Cromwell, G. W. Elliot, James Mills, J. H. Harris, W. H. Cutten, David Ross, W. J. M. Larnach, G. L. Sise, Rev. R. L. Stanford, Keith Ramsay, Robert McLaren, W. C. Roberts, W. Dalrymple, R. M. Robertson, N. A. Wales, L. J. Butterworth, Donald Reid, J. L. Gillies, T. W. Kempthorne, Hugh McNeil, W. D. Mears, J. O. Eva, J. C. Thomson, E. de Montalk.

The chairman read a letter from his Honour the Superintendent, forwarding a copy of a circular addressed to him by the Hon. the Colonial Secretary, enquiring into the probability of such a collection of exhibits being secured as would ensure a worthy representation of New Zealand at the forthcoming exhibition at Philadelphia, in 1876. Before replying to the circular he (his Honour) would be glad to be favoured with the views of the

Otago Institute on the subject, and as to whether or not, and to what extent, it would be disposed to co-operate in the matter. Judging from the extent of contributions from the province to the late Exhibition at Christchurch, he was disposed to fear that there was not sufficient enthusiasm at present to go into the matter vigorously. His Honour would be glad to find in this matter, however, that he was mistaken. The enclosures in his Honour's letter showed that the Victorian Commissioners for the Philadelphia Exhibition proposed that a preliminary Intercolonial Exhibition should be held at Melbourne, from which a judicious selection might be made of objects most suitable for ultimate exhibition at Philadelphia.

Mr. Gillies: I am afraid there is something more than enthusiasm that this institution would need, namely, funds.

Captain Hutton: We, as a scientific society, have nothing to do with exhibitions, even if we had funds. We should decline to take any steps in the matter. It is out of our province.

Mr. Webb: The co-operation of the Institute might be asked for in regard to the mineral resources of this part of the colony.

On the suggestion of Mr. Gillies, the letter was referred to the council of the Institute for consideration.

ANNUAL REPORT.

The council can again congratulate the members on the continued progress of the Institute. During the year there have been nine general meetings held, which have been well attended. At these meetings twenty-one papers have been read by ten different authors, eight of whom are residents in this province, the other two being Dr. Otto Finsch, of Bremen, and Mr. W. Beddnal, of Adelaide. This is an increase of twelve papers and two contributing members over last year. Of these papers nine relate to zoology, five to geology and palæontology, three to botany, two to astronomy, two to Maori mythology, and one to medicine. Since the last annual meeting forty new members have joined us and one has retired, thus bringing our number up to 162 members. During the year the rules have been revised, printed, and distributed to the members, the most important change being that, instead of holding meetings all the year round, we have now a winter session from May to October inclusive.

The balance sheet showed that £108 6s. 3d. had been received, and £101 2s. 8d. expended, leaving a balance in hand of £6 13s. 7d.

The report and balance sheet were unanimously adopted.

The President then delivered the following

ADDRESS.

I may say that the great event peculiarly interesting to us during the past session has been the transit of Venus, so it is necessary for me to relate to you

what steps our Institute took in forwarding the interests and views of the observing parties sent from the opposite quarter of the globe to our shores. On learning, in the early part of last year, that two expeditions were to be sent to New Zealand—one being from England, and the other from the United States of America—I at once took measures to have your advice, as to the possible manner in which we might be useful. So, in compliance with my motion, a committee of the Institute was formed, when it was decided that the most necessary information to the leaders of the expedition would be in regard to climate, localities, and facilities for travelling. Maps and reports were consequently drawn up by this committee—consisting of Messrs. M'Kerrow, Skey, and myself—one packet of which was sent to the Astronomer Royal at Greenwich, the other to the States Astronomer at Washington. Whether the former reached its destination or not I am not aware, as I have been favoured with no reply to my letter accompanying the documents; but in regard to the latter we had immediate acknowledgment to the effect that our papers had been handed over to the leader of the expedition (Professor Peters), and who, on his arrival in New Zealand, would carefully consider our suggestions. Fortunately the American expedition was preceded by the second in command (Lieut. Bass), who, on his arrival, called on myself and Mr. M'Kerrow, and who, accompanied by the latter, proceeded into the interior to examine the country and judge of the climate for himself. Having done this, the expedition was waited for at Bluff Harbour. On the arrival of Professor Peters we were early informed that the recommendations of our Institute would be virtually followed, by the observing party proceeding into the interior and fixing their observatory at Queenstown, instead of remaining at the Bluff, as originally intended. The result you all know. The American expedition has been singularly and uniquely successful, they having obtained observations of the ingress of the planet on the sun's disc, besides securing 160 photographs of its positions while in transit—the latter being of the highest value to them. Professor Peters himself, when in Dunedin, did us the favour to explain to our Institute the peculiar value he set on his photographic diagrams in relation to the great power of the apparatus by which these were produced, its highly ingenious mode of application; also, in regard to its mathematical accuracy. Hence the high estimation which he put on what he had obtained. In this respect, also, he was greatly more completely equipped than any of the other expeditions observing in or near our shores. The scientific world may therefore particularly congratulate themselves on his success, as, owing to the failure of all other expeditions, the most valuable data have been secured for all nations.

Now, as Professor Peters himself remarked to us, what would have been the use of his coming here with all his delicate instruments, and at so great an

expense to his Government, had the transit of Venus been covered by clouds? None. To our local advice, therefore, he was so good as to ascribe his success. True, our assistance, though effectual, was that of humble friends—the assistance (if I may use a simile applicable to New Zealand with its dangerous mountain torrents) of those who not being skilful enough to construct the "mogie" or native raft, have by their local knowledge shown to the wanderer the safe ford which has led to success. The American expedition fixed their site for observation twenty-six miles westerly of the particular locality that we had recommended, from which it is divided by two ranges of mountains 5000 feet to 6000 feet in altitude. So, on their success and the complete failure of all other practical and scientific observers in New Zealand by reason of the weather, it became of interest to us to know the state of the atmosphere over the exact locality recommended by your committee, viz., the lower valley of the Manuherikia, and to this end I solicited the assistance of Mr. Lubecki, superintendent of the provincial telegraph lines. The result of the information that he has given me, as obtained from the telegraph offices of Clyde, Alexandra, and Ophir, is to the effect that the weather in their districts was highly favourable—indeed, quite as much so as at Queenstown. Thus, your committee was more than justified in pressing its experience on the English and American astronomers. But, gentlemen, having done this we must not rest contented. Another transit takes place between seven and eight years hence. By that time, what with our High Schools and Universities, I hope, under the auspices of the New Zealand Institute, to which we are affiliated, we may have the talents and acquirements within the colony at large, not only to observe, but to make independent deductions in one of the most subtle problems that engage the attention of astronomers. Further, I may hope that the Government of New Zealand will be strong and wealthy enough by that time to economise, by making use of these talents and acquirements, by fitting out expeditions on its own account.

On another subject I would desire to shortly detain you. While meantime enterprise from our shores is now extending itself over the balmy climates of Polynesia, drawing from thence wealth and gain ; while, also, our Colonial Government, by the institution of training ships, is nurturing our seafaring interests, we should not neglect the more stormy and forbidding regions to the southward of us, an arena peculiarly belonging to Otago. It is in these regions that we have a nursery for seamanship and hardihood, such as those wherein the bravest and most useful of British sailors were bred. These southern seas are a prototype of the polar seas of the Northern Atlantic, and are within five to ten days' sail of us.

But our attention as a scientific society is not directed to the wealth in oil and other polar produce, which Sir James Ross assures us may there be

obtained, but rather to the geography, geology, and natural history of the great Antarctic Continent. What the above navigator did in a sailing ship, whose basis of operations was England, with great difficulty, we, by means of steam, would accomplish with comparative ease; and, moreover, in imitation of our northern brethren, in an opposite direction, if our ambition as yet be not to reach the South Pole, there is a vast field in Victoria Land for the investigations of the naturalist. The region is within the limits of the permanent habitation of man, as proved by the experience of the northern hemisphere. Then, is it inhabited, and by what race of people? If so, do they differ in form from other men? Or, considering the great alterations of climate that have been proved in New Zealand, if not now, may not the region have once been inhabited? If so, what new light would the fossil remains cast on a momentous question that now troubles men's thoughts? Science is ever scrutinising, and its greed after a comprehension of creation will never be allayed. Think not these speculations to be far fetched, for have we not proved an inscrutable link in language between the Murihiku Maori and the far distant Malagasi, and do not the peculiarities of the fauna bear also strange parallels? Yet these regions are immensely more apart than is New Zealand from Victoria Land.

That this mysterious land can be reached we know; that it has been landed on we also know; but that it has a secure harbour is yet to be proved. But, could this be found, then we would have a basis of exploration in the various branches of science so new that such an event has not occurred for many a day. Should this prove a new field—should it open new portals to scientific investigation—it would be pleasing if our Institute should, by its influence, aid towards this end.

In conclusion, I may congratulate the Institute on the fact that the several scientific men attached to the transit of Venus expeditions have been active in collecting subjects of natural history, not only in this, but in the islands of the surrounding seas. Thus, through them and in their connection with the Museum here, a great advance will this year be made on our previous knowledge, which will extend itself to the older and more powerful nations of the northern hemisphere.

Mr. Gillies remarked that he found from the treasurer's balance sheet that the sum of £50 had been contributed during the year, out of an income of £86, to the Otago Museum for the purchase of books. He had brought this subject up on more than one occasion already. This Institute occupied an anomalous position in reference to the Museum. The Otago Institute was a public body, contributed its own funds towards carrying on its special work, the officers were elected at the annual meetings, which were open to the public, and the public to a certain extent had control over the Institute. It was not so with

the Otago Museum committee. He really at the present moment did not know who were the members of this body, how they were elected, and whether there was any check over the proceedings. There was certainly no public check over the committee of the Museum. Now, he did not think that this was a desirable position for the committee of a public institution. He had always taken a very warm interest in the Museum and Institute. He thought that the fact that this Institute had been in existence for a number of years, and had been kept together by the enthusiasm of a few, who did not lay any claim to any great scientific wisdom, but who desired to see these things prosper, was to a certain extent a guarantee that their hearts were in the work. For his own part, he desired that the Museum should be either under the direction of the Otago Institute, or, at any rate, should be managed by a public body over which the public should have some say or control. He was not prepared to say that the Institute should not contribute to the funds of the Museum; he did not go that length; he liked to see the Museum prosper, but he could not help regretting that the Museum was still in that position he had described. He might point out that by their rules the Institute was bound to give one-third of its funds to some public library or museum. The Institute had gone a long way beyond this, having given a sum of £50 out of an income of £86.

Captain Hutton replied at some length. He pointed out that the General Government subscribed equivalent to pound for pound, and had made it a condition for doing so that one-third of the revenue should be given to some public library.

Mr. Webb thought that Captain Hutton had misunderstood the drift of Mr. Gillies' remarks, which were to the effect that the Museum should be placed under the care of a committee, or be incorporated, instead of being an appendage of a Provincial Government department.

Captain Hutton, in reply, objected to the Museum, which was a public institution, being placed under the control of a private body like the Otago Institute. The Museum was better far under its present management. It was getting on well, and with the change proposed the public would not take so much interest in it.

Mr. Gillies explained that it was far from him to find any fault with the voting of the money towards the Museum—he was glad the council had done so. But he must say, and he thought it should be known by the public, that the members of the committee of the Museum did not give that attention to the affairs of their institution which might be expected from them. He had occasion some time ago to go round town with a subscription list for the purchase of some shells which Captain Hutton was extremely anxious to secure for the Museum. Instead of being assisted by members of the Museum committee, he was actually treated in a contrary way. He felt it was not right

that the position of the Museum should be such that there should be on its committee members who not only took no interest in it, but threw cold water on those desiring to aid it.

After some further discussion,—

It was resolved that it be an instruction to the council to contribute a sum of not less than one-third of the annual income to the Museum.

Captain Hutton mentioned that in the new building that was being erected there was a lecture-room, which the Otago Institute could use, and a private room.

Election of Officers for 1875.—*President*—J. S. Webb; *Vice-Presidents*—J. T. Thomson, F.R.G.S., P. Thomson; *Council*—Professor Millen Coughtrey, Dr. Hocken, A. Bathgate, H. Skey, D. Brent, G. M. Thomson, and J. M'Kerrow; *Hon. Treasurer*—R. Gillies; *Hon. Secretary*—Captain F. W. Hutton, F.G.S.

In proposing Mr. Webb as President, Mr. Gillies said he would propose a gentleman who had been connected with the Institute from the commencement, and who, more than anyone else, had claim to the title of founder. He alluded to Mr. J. S. Webb, a gentleman who should in fact have been already elected to that position.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

FIRST MEETING. *21st August*, 1874.

The Bishop of Nelson, Vice-President, in the chair.

The secretary reported having received from the New Zealand Institute sixty-two copies of Vol. VI. of the Transactions and Proceedings of the New Zealand Institute.

Letter read, from the Smithsonian Institute, Washington, U.S., accompanying a parcel of valuable statistical and other works.

Resolved,—That a letter of thanks be written to the secretary of the Institute for same.

SECOND MEETING. *10th November*, 1874.

T. Mackay, C.E., in the chair.

The Bishop of Nelson was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act.

The nomination for the election of honorary members of the New Zealand Institute was made, in accordance with Statute IV.

THIRD MEETING. *10th January*, 1875.

T. Mackay, C.E., in the chair.

The secretary reported having handed over to the Nelson Institute last year 203 publications, principally of a scientific nature, of the value of £36.

FOURTH MEETING. *5th April*, 1875.

The Bishop of Nelson, Vice-President, in the chair.

The report and accounts of last year were read and adopted.

ELECTION OF OFFICERS FOR 1875.—*President*—Sir David Monro; *Vice-President*—The Bishop of Nelson; *Council*—Leonard Boor, M.R.C.S., Charles Hunter-Brown, F. W. Irvine, M.D., Hon. Thos. Renwick, Joseph Shephard, Geo. Williams, M.D.; *Hon Treasurer and Secretary*—T. Mackay, C.E.

1. "On the Date of the Glacial Period; a Comparison of Views represented in Papers published in the Transactions of the N. Z. Institute, Vols. V. and VI.," by A. Dudley Dobson, C.E., Provincial Engineer. (*Transactions*, p. 440.)

2. "On the Glacial Period of New Zealand," by Thomas Mackay, C.E. (*Transactions*, p. 447.)

These papers were read by the Vice-President.

The secretary reported the donation, by the Hon. W. B. D. Mantell, of thirty-four volumes of "Notes and Queries."

Resolved,—That the thanks of the Association be transmitted to the Hon. Mr. Mantell for his valuable donation.

The secretary reported the receipt, from the director of the Geological Survey and Colonial Museum, of eighty-six packages of seeds of European, Asiatic, and American trees and shrubs; and, further, that in accordance with his arrangement with the director he had placed the seeds in the hands of Mr. John Hale, nurseryman, Waimea Road, Nelson, for their propagation and distribution on terms to be arranged by Dr. Boor and the secretary with Mr. Hale.

The secretary reported having handed over to the Nelson Institute since 1st January ninty-nine publications, principally of a scientific character, of the value of £16.

The Vice-President reported his intention to read at next meeting a paper on, and exhibit the skeleton of, a small whale which had been recently found imbedded in ground that had been excavated for the railway at Westport.

NEW ZEALAND INSTITUTE.

Sixth Annual Report.

The Board of Governors met during the past year for the transaction of business on the 29th of July, 1873, and 6th of January, 1874.

The retiring members of the Board for the year were reappointed, and the Governors elected by the affiliated societies were—Mr. Justice Chapman, Mr. Rolleston, M.H.R., and Mr. J. C. Crawford.

The following foreign members were elected for the year, in accordance with Statute IV.:—Sir Charles Lyell, Bart., F.R.S.; Albert Günther, M.D., F.R.S.; Rev. O. Pickard Cambridge, M.A., C.M.Z.S.

The number of members now on the roll of the Institute is as follows:—

Honorary Members	18
Ordinary Members:	
Auckland Institute	214
Wellington Philosophical Society	146
Otago Institute	128
Philosophical Institute of Canterbury	76
Nelson Association	59
Making a total of	641

The Institute has lost one foreign member during the year, by the death of Professor Louis Agassiz.

Each of the members included in the above list receives a copy of the sixth volume of the Transactions and Proceedings of the Institute, free of cost.

The free list, a copy of which is appended, requires seventy-nine volumes; and the remainder of the edition of 900 volumes is reserved for sale at £1 1s. each to private individuals, and at half price to local libraries in the colony.

The printing of the sixth volume was commenced in January last, but owing to the excessive demand for all kinds of labour during the present season, from the influence of which the printer's business was not exempt, the contract could not be completed so soon as usual, and the book was not issued until the end of June. Some extra delay was also caused through the late date at which the papers were received, and to allow Mr. J. T. Thomson to correct the proof sheets of his ethnographical paper; and, lastly, owing to the very large number of illustrations.

The volume contains 560 pages, with thirty-five plates and several woodcuts. Eighty-one articles were selected by the Board, and printed in the volume. These are by forty-two authors, and have been arranged as follows:—

	Papers.	Pages.
Miscellaneous	28 ...	61
Zoology	30 ...	146
Botany	10 ...	44
Chemistry	3 ...	20
Geology	10 ...	95
Proceedings of Societies	... ...	88

In the Proceedings will be found abstracts of thirty-three communications, which were not considered suitable for printing in the Transactions.

Mr. Thomson's paper was placed in an appendix, in order to avoid as much as possible delaying the rest of the work while the proof sheets were sent to Dunedin for revision.

In the Appendix will also be found two articles not directly connected with New Zealand, and a reprint from the "Annals and Magazine of Natural History," which has been made at the suggestion of the Philosophical Institute of Canterbury.

The illustrations of the papers by Dr. Buller (Plate XXI.) and the Rev. O. P. Cambridge (Plate VI.), were executed in London, and Plate I. (on Mr. Thomson's paper) in Dunedin. The remainder of the illustrations have been printed, by permission of the Hon. the Colonial Secretary, at the Government Lithographic establishment. The other drawings on stone were made from the original objects, by Mr. John Buchanan, of the Geological Department, except in the case of those illustrating Dr. Knight's paper on the Structure of the Saurian Teeth (Plates XXIV.–XXVI.), which were drawn on the stone by the author himself.

The valuable services afforded by the assistant editor, Mr. A. T. Bothamley, in passing the work through the press, and by Mr. R. B. Gore, in preparing the abstract of the Meteorological Observations which will be found in the Appendix, have to be acknowledged.

The following papers submitted to the Board for approval have been reserved:—

1. Cosmography, by J. Leith.
2. Remarks on Mr. Leith's paper, by T. Heale.
3. Remarks on Dr. Basstian's work on Beginnings of Life, by T. Heale.
4. Induction and Necessary Truth, by Dr. Kidd.

Dr. Haast's valuable paper on the *Harpagornis* has been entitled "Abstract," but it is necessary to explain that only paragraphs repeated from his previous paper on the same subject (Art. XXVIII., Vol. IV.) have been omitted, the author having prepared a complete résumé of the whole

subject, to be printed in quarto form, with the illustrations of natural size. The funds at the disposal of the Board will not, however, for the present, allow of the production of the series of quarto monographs that are contemplated, of which Dr. Haast's papers are to be the first.

The reprint of Vol. I. of the Transactions, which was undertaken by Government, has not yet been published, owing to the pressure of work in the Government Printing Office.

The number of volumes now on hand is as follows:—Of Vol. I., 5 copies; Vol. II., 36 copies; Vol. III., 31 copies; Vol. IV., 35 copies; Vol. V., 119 copies.

The statement of accounts of the Institute by the Honorary Treasurer is appended, and shows a balance in hand of £209 9s. 5d.

Reports showing the progress of the work in the various departments under the Manager's direction are appended.

JAMES HECTOR, Manager.

7th August, 1874.

FREE LIST FOR ISSUE OF THE TRANSACTIONS.

Governors of the Institute, 12 copies. (See printed list in Transactions.)
Honorary members, 18 copies. (See printed list in Transactions.)
The Prime Minister.
The Colonial Treasurer.
The Native Minister.
The Under Colonial Secretary.

Foreign Societies, Libraries, etc.

The Colonial Office, London.
The Agent-General, London.
Trübner and Co. (Agents), London.
The British Museum
The Royal Society.*
The Royal Geographical Society.*
Ethnological Society.*
Geological Society.*
Zoological Society.*
Geological Survey of the United Kingdom.*
Geological Magazine. (For review.)
Literary Institute, Norwich, England.*
The University Library, Edinburgh.
The Royal Society, Dublin.*
The Philosophical Society of Leeds, England.*
Smithsonian Institute, Washington.*
Geological Survey of India.*
Royal Society of Tasmania Library.*
The Public Library of Melbourne.
South Australian Institute Library.*
Royal Society of Victoria.*
University Library, Sydney.
Public Library of Tasmania.
Legislative Library, Adelaide.
Public Library, Sydney.
Royal Society, New South Wales.*
Academy of Natural Science Library, Philadelphia, U.S.*
Academy of Natural Science, San Francisco.*
Oxford University Library, England.

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* Exchanges.

Imperial German Academy of Naturalists, Dresden.*
Cambridge University Library, England.
His Excellency Governor Weld, Western Australia.
Professor Balfour, Edinburgh.
Professor McCoy, Melbourne.
Chairman of School Library Committee, Eton, Bucks, England.
Chairman of School Library Committee, Harrow, England.
Chairman of School Library Committee, Rugby, Warwickshire, England.
President of Natural History Society, Marlborough College, Marlborough, Wilts.
Colonel Jewett, New York.
Dr. Wojeikof, of St. Petersburgh.
Hon. Mr. Casey, Victorian Government.

Libraries and Societies in New Zealand.

Secretary, Auckland Institute.
Secretary, Wellington Philosophical Society.
Secretary, Philosophical Institute of Canterbury.
Secretary, Nelson Association for promotion of Science and Industry.
Secretary, Otago Institute.
General Assembly Library.
Provincial Council Libraries, nine copies.

Publishing Branch.

Editor.
Assistant Editor.
Draftsman, two copies.
Lithographer.
Government Printer.

Total, 97 copies.

MUSEUM.

No additions or alterations have been made to the Museum building during the past year, and the only expenditure has been for a few cases and drawers to enable the collections of fossils made during the season to be sorted and examined.

The accommodation for this and all other departments of the Museum is still quite insufficient, and the state of the building itself is such as to cause serious deterioration of the valuable collection which has been accumulated. Nothing short of the completion of the building according to the original plan will afford the accommodation that is now required for the arrangement of a type museum; and even then, to obtain sufficient space to enable the collections to be thoroughly comprehensible and easy of reference, a number of the larger specimens will have to be disposed of by exchange or gift. An expansion of the department of the Museum devoted to the Vegetable Kingdom is urgently required, to meet the applications that are very frequently made for information respecting vegetable products.

The number of specimens added to the Museum during the year has been over 20,000, of which 18,000 are fossils collected by the Geological Survey Department. About 600 specimens have been distributed as exchanges, and 205 bird skins have been presented to the Otago Museum.

Mammalia.—Several additions to the Cetacean collections have been secured, among which is a complete skeleton of the Sulphur Bottom Whale,

* Exchanges.

70 feet in length, obtained in Port Underwood; and also one of the Fin Back, procured for the Museum by Mr. Charles Traill in Stewart Island. The comparison of these skeletons, when they arrive at the Museum, will help to settle some important points in the natural history of this species. The skull of a calf of *Neobalæna marginata,* and several other interesting Cetaceans have also been lent by the Auckland Museum, for the purpose of being described. Among the *Foreign Mammalia* the most important additions have been a fine collection of eighty specimens of the Rodents of North America, presented by the Smithsonian Institute, and twenty-four specimens of Reptiles from South Australia, sent by Mr. Waterhouse.

Birds.—The chief addition to the New Zealand birds has been the acquisition of a large number of skins of huias, kiwis, kakapos, and other specimens that, from their rarity, are useful for exchange. The only species added to the type collection is a specimen of *Procellaria lessoni,* obtained from the Chatham Islands.

Of foreign birds, the Museum has received from Mr. R. L. Holmes a fine series of those indigenous to the Fiji Islands; also a collection, from the Northern Territory of Australia, from the South Australian Museum; and a selection of North American species from the Smithsonian Institute.

A mounted collection of the New Zealand Raptores was sent by Dr. Buller from London, including a specimen of the great eagle, which is stated to have been shot off the east coast of Wellington.

Reptilia.—In this section the chief additions are the snakes of Fiji and South Australia, but the collections in this class are still very incomplete.

Fishes.—Thirteen fishes have been added to the fauna of New Zealand during the past year, the most interesting being those obtained in deep water off the coast by the "Challenger Expedition." A fine specimen of the *Ceratodus,* the fresh-water ganoid fish of Queensland, has also been presented to the Museum by Professor Wyville Thomson. Descriptions of some of these species will be found in the Transactions of the New Zealand Institute.

Invertebrata.—Besides many additions to the New Zealand collection in this class, an interesting series of Crustacea and Annelida, from Spitzbergen and the coast of Scandinavia, has been presented by Professor Loven. Valuable additions to our Australian and Tasmanian shells have also been received from Dr. Cox, Mr. Gritton, and Mr. Gordon Saxby.

The Critical List of the New Zealand Mollusca by Dr. Von Martens, and also the Descriptive Catalogue of the Land Shells by Dr. Cox, have been published. Attention has also to be directed to the valuable lists of all the New Zealand Insects described up to 1870, prepared by Captain Hutton and Mr. R. W. Fereday, which have been published in the Transactions of the New Zealand Institute, Vol. VI., which also contains the Rev. O. P. Cam-

bridge's introduction to the study of the Spiders of this country, and a Descriptive List of the Neuropterous Insects of New Zealand by Mr. R. McLachlan.

Palæontology.—Very large additions have been made to the collection of Fossils, both from sections formerly examined and from new localities and formations. Chief among these are the richly fossiliferous limestones and quartzites of lower Devonian or upper Silurian age, which underlie unconformably the auriferous rocks of Reefton, and from which over 2000 specimens have been obtained. As this formation enters largely into the structure of the highly mineralized N.W. district of the South Island, the establishment of an easily recognized zone is most advantageous to the geology of the colony.

The interesting character of the small collection of fossils formerly obtained from the south-east district of Otago, indicating the probable existence of a passage group from lower mesozoic to palæozoic, suggested the importance of having further collections made from the sections afforded in the vicinity of Nugget Point and Catlin's River. For this work Mr. McKay, who conducted the excavations for Saurian remains at Amuri Bluff so successfully, was selected; and in the course of three months he obtained nearly 3000 fossils, which are as yet only partially worked out, but they serve to prove the existence in that district of a range of formations from lower jurassic to upper carboniferous.

A comparison of the upper coal formations on the east side of the South Island with those on the West Coast, and of more ample collections of fossils from the overlying formations, has shown that the bituminous coal seams on the west occur in a lower part of the formation that carries the brown or hydrous coal seams on both sides of the island, and that the whole, together with an immense thickness of overlying marine formation, must be referred to the cretaceous period. This view has been further established by a survey of the East Cape district of the North Island, and the general results obtained will also require a revision of the present classification of the lower tertiary strata, as the evidence and re-establishment of a cretaceo-tertiary formation having for its upper member a representative of the nummulite limestone.

A special geological survey of the East Cape district of the North Island was made, to investigate the source of the petroleum which springs from the surface of the ground in many localities. This survey is not yet complete, but the information obtained indicates that the mineral oil is derived from bituminous shales of upper jurassic age.

The particulars of the various geological operations in the field will appear in a volume of Report of the Geological Survey; and it may be mentioned

that the general geological map of the colony that was sent to the Vienna Exhibition is now in course of publication in Europe.

LABORATORY.

The number of analyses made during the past year was 356, viz.,—35 coals, 77 minerals, 37 ores, 10 waters, 31 gold assays, and 166 miscellaneous.

The particulars of these analyses will be found in the usual Annual Report by the Analyst.

JAMES HECTOR.

ACCOUNTS OF THE NEW ZEALAND INSTITUTE FOR 1873-4.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
Balance in hand, August, 1873...	181	13	3	Expenses of printing Volume VI.	520	11	0
Vote for 1873-74	500	0	0	Miscellaneous—Binding, Advertising, &c.	2	1	6
Contribution from Wellington Philosophical Society	24	9	8	Balance	209	9	5
Sale of Transactions	25	19	0				
	£732	1	11		£732	1	11

A. LUDLAM, Treasurer.

Wellington, 10th August, 1874.

APPENDIX.

ERRATA.

THE "Minimum Temperature on Grass," or terrestrial radiation readings for *Bealey*, which appear in Table VI. of the Reports on the Climate of New Zealand, published in Vols. V., VI., and the present Vol. (VII.), are unreliable, owing to errors in the instrument.

THE CLIMATE OF NEW ZEALAND.

METEOROLOGICAL STATISTICS.

THE following Tables, etc., are published in anticipation of the Report of the Inspector of Meteorological Stations for 1874.

TABLE I.—TEMPERATURE of the AIR, in shade, recorded at the Chief Towns in the NORTH and SOUTH ISLANDS of NEW ZEALAND, for the year 1874.

Place.	Mean Annual Temp.	Mean Temp. for (SPRING) Sept., Oct., Nov.	Mean Temp. for (SUMMER) Dec., Jan., Feb.	Mean Temp. for (AUTUMN) Mar., Apl., May.	Mean Temp. for (WINTER) June, July, Aug.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.
NORTH ISLAND.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Mongonui	62·9	59·7	69·5	66·1	56·2	14·6	54·0
Auckland	59·7	56·9	67·3	62·7	52·4	14·8	52·9
Taranaki	57·0	55·3	63·4	58·7	50·6	17·0	59·0
Napier	58·0	57·4	66·4	58·8	49·6	18·2	59·0
Wanganui	55·2	54·4	62·1	56·9	47·5	19·9	55·0
Wellington	54·7	53·5	62·1	55·5	47·6	11·8	45·7
Means, etc., for North Island	57·9	56·2	65·1	59·7	50·6	16·0	59·0
SOUTH ISLAND.							
Nelson	55·2	55·0	63·8	55·9	46·7	22·1	63·0
Cape Campbell ...	*58·1	56·9	64·7	58·9	48·4	13·2	44·5
Christchurch ...	52·2	51·8	62·0	52·6	42·6	15·5	62·7
Hokitika	52·4	51·1	58·9	53·8	45·8	13·8	48·4
Dunedin	49·7	48·9	57·4	51·0	41·4	14·5	55·0
Queenstown	48·8	48·0	59·6	50·4	37·2	15·5	61·4
Southland	—	48·5	56·3	—	—	—	—
Means, etc., for South Island	52·7	51·4	60·3	53·7	43·7	15·7	63·0
Means for Nth. and Sth. Islands	55·3	53·8	62·7	56·7	47·1	15·8	63·0

* For 11 months only.

TABLE II.—Barometrical Observations.—Rainfall, etc., recorded for the year 1874.

Place.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
North Island.	Inches.	Inches.	Inches.	Sat.=100.	Inches.	0 to 10.
Mongonui ...	29·995	1·213	·451	78	56·950	5·6
Auckland ...	29·952	1·233	·410	78	35·024	6·3
Taranaki ...	29·938	1·191	·353	76	57·220	6·1
Napier	29·933	1·448	·377	77	37·940	2·6
Wanganui ...	30·052	1·500	·325	74	36·930	5·2
Wellington ...	29·945	1·402	·339	79	53·496	5·4
Means for Nth. Island	29·969	1·331	·375	77	46·260	5·2
South Island.						
Nelson	29·888	1·305	·343	77	71·550	4·8
Cape Campbell ...	29·940	1·530	·348*	72*	28·150	6·2
Christchurch ...	29·922	1·696	·324	81	22·790	5·7
Hokitika... ...	29·915	1·399	·336	84	104·480	5·0
Dunedin	29·719	1·369	·286	79	28·739	5·5
Queenstown ...	29·860	1·890	·237	69	30·190	5·1
Southland ...	29·854	1·450	—	—	44·650	6·6
Means for Sth. Island	29·871	1·519	·312	77	47·221	5·5
Means for Nth. and Sth. Islands	29·920	1·425	·343	77	46·740	5·3

* For 11 months only.

TABLE III.—Wind for 1874.—Force and Direction.

Place.	Average Daily Velocity in miles.	Number of days it blew from each point.								
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.*
North Island.										
Mongonui ...	144	12	43	50	49	24	73	45	69	0
Auckland ...	308	40	73	13	30	67	68	43	30	1
Taranaki ...	201	31	46	30	84	9	73	52	40	0
Napier	214	56	69	11	30	70	53	35	36	5
Wanganui ...	244	14	19	10	39	5	54	34	112	78
Wellington ...	236	15	13	6	123	1	13	4	186	4
South Island.										
Nelson	89	56	49	27	80	16	54	27	56	0
Cape Campbell...	435	7	1	3	116	59	1	28	147	3
Christchurch ...	133	1	121	31	29	11	130	1	41	0
Bealey	136	1	31	10	56	2	22	1	194	48
Hokitika ...	181	60	102	96	14	6	43	17	27	0
Dunedin ...	157	29	55	8	23	29	67	47	9	98
Queenstown ...	140	10	17	1	7	2	38	18	134	138
Southland ...	190	24	59	52	10	6	83	56	75	0

* These returns refer to the particular time of observation, and not to the whole twenty-four hours, and only show that no direction was recorded for the wind on that number of days.

TABLE IV.—Bealey—Interior of Canterbury, at 2104 feet above the sea.

Mean Annual Temp.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
Degrees.	Degrees.	Degrees.	Inches.	Inches.	Inches.	Sat.=100.	Inches.	0 to 10.
46·2	17·0	77·2	29·960*	1·340	·263	82	98·095	5·1

* Reduced to sea level.

TABLE V.—Earthquakes reported in New Zealand during 1874.

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Auckland	...	...	...	...	...	...	...	...	...	28	...	..	1
Taranaki	...	...	9	...	...	...	...	...	14	...	...	...	2
Tarawera	...	...	7	...	...	...	...	...	...	...	...	...	1
Opunaki	...	...	...	...	...	...	4*, 28	...	...	...	...	15	3
Patea	...	...	9	...	...	...	...	...	...	...	...	...	1
Napier	29*	...	...	...	...	...	...	3*, 4*	...	...	14	...	4
Tauranga ...	21 23 24*	28†	...	...	...	...	...	...	...	...	...	...	4
Wanganui ...	...	...	4, 9*	...	...	23	28*	18	...	...	...	...	5
Rotorua	...	...	...	...	...	9	...	...	...	...	...	...	1
Wairoa	...	...	...	...	...	...	...	3*	...	...	...	...	1
Foxton	...	...	9, 11	...	...	...	...	...	...	...	...	..	2
Akitio	...	...	...	...	...	...	...	4, 6	...	...	...	...	2
Wellington ...	..	...	1, 17	...	...	...	...	5, 15	...	...	...	...	4
Masterton... ...	...	...	1	...	...	...	...	9	...	...	...	...	2
Cape Campbell ...	...	...	...	...	...	...	...	...	...	...	27	...	1
Christchurch ...	...	...	25*	...	...	6	...	...	...	...	...	1	3
Lyttelton	28†	...	25*	...	...	6*	...	...	...	...	...	...	3
Dunedin	...	1, 4	...	...	...	20*	...	...	...	...	...	..	3
Queenstown ...	...	1	...	...	...	...	...	...	...	18	...	...	2
Akaroa	...	...	25*	...	...	...	...	...	...	...	...	...	1
Mana Island ...	...	...	...	24	...	...	...	...	...	...	...	...	1
Riverton	...	2, 8*	...	...	...	20*	...	...	...	...	...	...	3
Bluff	...	2	...	...	...	20*	...	...	...	...	...	...	2

The figures denote the days of the month on which one or more shocks were felt. Those with an asterisk affixed were described as *smart*; those with a dagger as *severe shocks*. The remainder were only slight tremors, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. This table is therefore not reliable so far as indicating the geographical distribution of the shocks.

TABLE VI.—COMPARATIVE ABSTRACT for 1874, and previous Years.

STATIONS.	Barometer.		Temperature from Self-registering Instruments read in Morning for Twenty-four hours previously.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min. Temp. on Grass.	Mean Elastic Force of Vapour.	Mean Deg. of Moisture. (Saturation=100.)	Total Fall in Inches.	No. of Days on which Rain fell.	Average Daily Force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and date.	Mean Amount (0 to 10).
NORTH ISLAND.														
Mongonui	29·995	1·213	62·9	14·6	54·0	—	—	·451	78	56·950	165	144	680, 2 Aug.	5·6
Previous 8 years	29·973	—	59·9	—	—	—	—	§·417	§76	54·224	165	—	—	—
Auckland	29·952	1·233	59·7	14·8	52·9	158·0	10·0	·410	78	35·024	174	308	1012, 25 Aug.	6·3
Previous 10 years ..	29·930	—	59·6	—	—	—	—	·412	79	45·012	185	—	—	—
Taranaki	29·938	1·191	57·0	17·0	59·0	182·0	—	·353	76	57·220	167	201	665, 13 May	6·1
Previous 10 years ..	29·933	—	57·4	—	—	—	—	‖·373	‖73	56·612	159	—	—	—
Napier	29·933	1·448	58·0	18·2	59·0	144·0	—	·377	77	37·940	147	214	919, 27 Sep.	2·6
Previous 6 years	29·917	—	58·1	—	—	—	—	·390	75	35·653	93	—	—	—
Wanganui	30·052	1·500	55·2	19·9	55·0	145·0	28·0	·325	74	36·930	131	244	535, 25 Oct.	5·2
Previous 2 years	30·070	—	55·9	—	—	—	—	·330	72	38·420	128	—	—	—
Wellington	29·945	1·402	54·7	11·8	45·7	142·0	23·0	·339	79	53·496	191	236	885, 8 Sept.	5·4
Previous 10 years ..	29·890	—	54·5	—	—	—	—	·328	72	50·872	155	—	—	—
SOUTH ISLAND.														
Nelson...	29·888	1·305	55·2	22·1	63·0	159·0	—	·343	77	71·550	95	89	303, 8 Mar.	4·8
Previous 10 years ..	29·901	—	55·6	—	—	—	—	·367	74	62·629	88	—	—	—
Cape Campbell ...	29·940	1·530	58·1†	13·2	44·5	—	—	·348†	72†	28·150	109	435	1134, 12 June	6·2
Christchurch	29·922	1·695	52·2	15·5	62·7	158·0	15·2	·324	81	22·790	120	133	519, 25 Aug.	5·7
Previous 10 years ..	29·871	—	53·7	—	—	—	—	·327	77	25·727	116	—	—	—
Bealey*	29·960	1·340	46·2	17·0	77·2	—	- 20·2	·263	82	98·095	170	136	395, 25 Mar.	5·1
Previous 6 years	29·782	—	46·4	—	—	—	—	·262	81	97·529	175	—	—	—
Hokitika	29·915	1·399	52·4	13·8	48·4	98·2	21·2	·336	84	104·480	171	181	507, 16 Apl.	5·0
Previous 8 years	29·932	—	52·6	—	—	—	—	·358	86	113·116	189	—	—	—
Dunedin	29·719	1·369	49·7	14.5	55·0	168·0	21·0	·286	79	28·739	156	157	615, 3 Oct.	5·5
Previous 10 years ..	29·873	—	50·6	—	—	—	—	·280	73	33·022	166	—	—	—
Queenstown	29·860	1·890	48·8	15·5	61·4	172·7	22·1	·237	69	30·190	115	140	280, 8 Mar.	5·1
Previous 2 years	29·987‡	—	51·1	—	—	—	—	·253	67	30·590	124	—	—	—
Southland	29·854	1·450	—	—	—	—	—	—	—	44·650	206	190	677, 13 Oct.	6·6
Previous 9 years	29·796	—	¶49·9	—	—	—	—	¶·274	¶75	45·779	159	—	—	—

* 2104 feet above sea level.
† For 11 months only.
‖ Previous 9 years.
‡ Previous year only.
¶ Previous 8 years.
§ Previous 7 years.

Notes on the Weather during 1874.

January.—Remarkably dry weather throughout, rainfall considerably below the average; usually a high atmospheric pressure and temperature; winds prevailed from W., and on the whole light; a severe storm, however, passed over the northern part of province of Canterbury on 11th, doing considerable damage; it was not severely felt at Christchurch. Earthquakes occurred on 21st at Tauranga, four shocks between 7 a.m. and 6 p.m., rather strong; and on 23rd two shocks at 5 p.m.; also four smart shocks on 24th, between 6 and 8 a.m.; at Napier on the 29th, 9.15 p.m., smart. Brilliant meteor observed on 13th in north; aurora in south, on 18th.

February.—The temperature throughout is about the average for this month, but the rainfall is considerably less. With the exception of the severe S.E. and N.E. gale which occurred in Auckland on 7th and 8th, the winds have been moderate. Earthquakes reported on the 1st at Dunedin and Queenstown, slight; also on the 4th two distinct shocks at Dunedin, and on 2nd slight shocks at Riverton and Bluff, at night; on the 8th, rather a severe shock at Riverton; on 28th, at 3 am., a severe shock was felt at Lyttelton and Tauranga.

March.—The weather was wet throughout, at the same time very mild and temperate for the time of year, and no gales of any violence have occurred. Earthquakes were reported as having been felt at the following places:—At Wellington and Masterton, on 1st, at 12.10 p.m., slight, and at the former place on 17th, at 11.30 a.m., slight; at Wanganui, on 4th, at midnight, and on 9th, same time, sharp; at Tarawera, on 7th at 10.27 a.m., slight; at Taranaki, on 9th, at midnight, slight; Foxton and Patea, on 9th, at midnight, slight; also at Foxton, slight shock on night of 11th; at Christchurch, Lyttelton, and Akaroa, on 25th, at 12.3 a.m., a prolonged shake. Meteors observed at Dunedin on 13th, and at Queenstown on 21st.

April.—The most remarkable feature in the weather during this month was the unusually small rainfall at all the stations in the colony, except those on the west coast of the South Island, at Bealey, and in the extreme south, where the rain was excessive. At most of the stations the weather was exceedingly fine and pleasant; slight shock of earthquake reported at Mana Lighthouse on the 24th, at 11 p.m. Meteor observed at Wanganui on 1st, at 7.30 p.m.

May.—The weather generally was fine for the time of year, although some strong S.E. gales were felt in the north; the rainfall below the average, especially on the West Coast, the weather there being unusually fine; the temperature rather low. The barometer fell as low as 28·998 on 24th, on which date a severe hail, rain, and thunder storm occurred at many of the stations.

June.—The rainfall for the whole colony for this month was rather less than the average for previous years, but at most of the stations in the North Island the fall was in excess, while in the south, and on the west coast of South Island, it was considerably under the average. No very severe gales are reported except at Cape Campbell, but the weather in the south was severe, frost and snow often occurring. Eearthquakes were felt at Christchurch on 6th, at 8.45 a.m., slight, but smart at Lyttelton; also felt at Kowai Pass. At Rotorua several shakes were felt on 9th; at Riverton, Bluff, and Dunedin on 20th, about 6 a.m., sharp; at Wanganui on 23rd, at 11.30 p.m., slight.

July.—Except at some of the stations in the north, the rainfall was generally under the average for previous years, and with one or two exceptions the winds were moderate; the temperature, however, was considerably below the average throughout, and high atmospheric pressure prevailed; frequent snow and hail storms occurred, and frosts, causing the weather to be unusually severe. Earthquakes were reported at Opunaki on 4th, at 9.35 p.m., sharp, preceded by loud rumbling; on 28th at Wanganui, 4.37 p.m., sharp shock, direction N.E. to S.W., twenty seconds' duration; and at Opunaki on same date a slight shock at 4.35 p.m., direction N. to S. Aurora visible in south on 25th.

August.—The rainfall for this month was at most of the stations greatly in excess, and the weather on the whole unusually stormy and severe. Earthquakes reported at Napier, 3rd, at 4.16 a.m., and 4th, smart; also Wairoa, on 3rd, at 4.10 a.m., smart; at Akitio on 4th at 12.15 p.m., and 6th, at 5.10 p.m.; at Masterton, afternoon of 9th; Wellington, 5th at 7.20 a.m., and 15th at 2.15 a.m., slight. Wanganui, 18th, 2 p.m., slight. Meteors and auroras observed.

September.—Unusually heavy rainfall throughout the colony, in some districts the floods causing considerable damage. Westerly winds prevailed, and at times strong gales occurred. Low atmospheric pressure, and temperature below the average; in the south the weather was occasionally very severe. Slight earthquake reported at Taranaki on 14th.

October.—The weather was generally stormy during this month, principally from the westward. Except in the extreme south, the rainfall was considerably below the average. The temperature was lower than what is usual for the

time of year, and at some stations the cold was severely felt. Sudden fall in the barometer on 12th, followed by a westerly gale, otherwise the pressure was steady. Earthquakes reported at Auckland on 28th, very slight; and at Queenstown on 18th at 3.21 p.m., slight.

November.—The weather during this month was, on the whole, fine and seasonable; rainfall moderate, and at some stations very slight; temperature about the average; no gales of any note occurred. Earthquakes reported at Napier on the 14th, at 1.30 p.m., slight; at Cape Campbell on 27th, at 9.30 p.m., slight.

December.—Very fine bright summer weather throughout month; pleasant showers, but slight rainfall, and winds generally moderate. Earthquake reported at Christchurch on 1st; and at Opunaki on 15th, at 8 a.m., slight.

*Notes on the Word "Moa," in the Poetry of the New Zealanders.** By the Rev. James W. Stack.

[*Read before the Philosophical Institute of Canterbury, 23rd December*, 1874.]

In a former paper, which appears in the fourth Vol. of the Transactions of the N.Z. Institute,† I stated that it could not be inferred, from the allusions to the Moa in the Poetry of the New Zealanders, that they were familiar with the bird the remains of which are now known by that name. This statement having been questioned, I have again examined the collection of poetry made by Sir George Grey, containing upwards of five hundred different pieces of composition. I met with the word Moa seven times.

First, upon page 9: "Ka ngaro i te ngaro a te *Moa*." Lost (or hidden), like the Moa is lost.

Granting that the poem in which this line occurs is an ancient composition, the allusion to the Moa may be accounted for by traditions now lost respecting the Hawaikian Moa. Succeeding generations probably asked—Where is the Moa of which tradition speaks, and of which the feathers are now treasured? "Lost," would be the reply, and then the saying would become proverbial,—Lost, like the Moa is lost. But if the phrase, "Ka ngaro i te ngaro a te *Moa*," in this lament of Ikaherengatu's, is to be taken as a proof of the acquaintance of the Maori with the *Dinornis*, it is at least a proof that the aged chiefs, who sang it, admitted that the Moa disappeared long ago, and not, as some think, quite recently.

On page 15, "E *moa*" is evidently a name.

On page 41, "*Moa* i roki roki." Moa is a contraction for moana (calm ocean).

On page 96, "Tu tonu Puhi raki, ko te *Moa* kaihau." Here Moa evidently means a bleak spot.

It is a question whether the phrase *Moa kai hau* ever did refer to the habits of the bird. The interpretation some Maoris now give may be only a gloss.

On page 133 we find the following curious allusion to the Moa:—"Te manu hou nei e, te *Moa*." This new bird, the Moa.

The composer of the sonnet in which this line occurs would hardly have called it a new bird if the Maoris had always been familiar with it.

* This paper was received too late for insertion in its proper place in the volume.

† Trans. N.Z. Inst., IV., Art. V.

On page 180—

"Tahuri mai o mata
Te tihi ki Tirau,
Mo wai roki roki
Ko te huna i te *Moa*
I makere iho ai
Te tara o te marama."

Moa here is a contraction for moana (ocean).

On page 324—

"Na hikuao te Korohiko
Ko te rakau i tunua ai te *Moa*."

(Of Hikuao was the Korohiko, the wood with which the Moa was cooked.)

Koromiko, or *Veronica*, was used by the Maoris in certain sacred rites, and tradition asserts that the twigs of the korohiko alone of all woods in the forest availed to cook the flesh of the Moa. It is difficult to accept this tradition as a plain statement of fact.

I am inclined to look upon the expressions, "Ka ngaro i te ngaro a te Moa," "Te Korohiko te rakau i tunua ai te Moa," and "Te Moa kai hau" (if the words refer to the Moa at all) as proverbial, and to be accounted for by the theory proposed in my former paper.* The absence of any reference to the appearance of the Moa, or to its habits, or to the hunting of it, is significant when taken in conjunction with the fact that frequent allusions of the kind are made with reference to other birds, and with reference to hunting and fishing. As, for instance, on page 62, "The owl is hooting near." On page 98, a charm to be used by rat hunters, also one for fishermen. On page 107, "The notes of the kiwi, weka, etc., sound in the listening ear." On page 109, enumerating feather ornaments, Moa omitted. On page 381, a charm for use by fishermen. On page 388, a charm for hue cooking.

After careful examination I cannot find any evidence in the Poetry of the New Zealanders, contained in the work to which I have referred, that the composers were familiar with the *Dinornis*. Though this work does not of course contain all the poetical compositions of the people, it is a fair sample of their productions, and must be more reliable for the purpose of affording evidence upon a disputed point than any subsequent collections made after controversy has arisen about the subject matter of the poems originally collected.

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* Trans. N.Z. Inst., IV., Art. V.

Abstract of Meteorological Observations taken at Delanasau, Bay of Islands, Bua, Fiji, for the year ending December 31*st*, 1873. By R. L. Holmes, F.M.S.

[*Read before the Wellington Philosophical Society, 8th August,* 1874.]

1873.	Aneroid Barometer.			Self-Registering Thermometers.				Rainfall.			
	Mean pressure of air.	Greatest pressure.	Least pressure.	Mean temp. in shade.	Max. temp.	Min. temp.	Mean daily range.	Total amount in inches.	Greatest daily fall.	No. of days it fell.	Hours of rain.
January ...	30·23	30·33	30·12	79·5	91·5	70·3	12·8	20·15	2·82	23	89
February ...	30·28	30·39	30·14	79·9	91·8	71·7	13·9	17·31	2·30	21	80
March ...	30·33	30·44	30·22	79·8	94·2	69·3	14·6	16·52	2·52	22	88
April	30·33	30·41	30·22	80·0	92·2	69·3	15·4	11·38	1·83	20	30
May	30·35	30·42	30·28	79·0	91·8	63·6	16·3	4·53	1·10	13	26
June	30·39	30·52	30·32	76·2	90·0	60·3	16·6	2·51	0·75	6	10
July	30·42	30·50	30·33	77·6	90·0	62·8	17·7	4·71	1·35	14	23
August ...	30·43	30·52	30·36	75·9	89·5	60·8	15·9	8·10	2·03	11	41
September ...	30·43	30·48	30·34	78·0	92·8	66·6	15·7	1·47	0·36	12	7
October ...	30·38	30·46	30·27	79·8	94·5	68·0	15·5	7·03	2·10	16	33
November ...	30·34	30·44	30·23	80·2	93·4	64·0	19·1	2·88	1·32	6	8
December ...	30·28	30·37	29·91	81·4	93·8	71·2	16·1	7·51	1·40	17	35
Year 1873 ...	30·35	30·52	29·91	78·9	94·5	60·3	15·8	104·10	2·82	181	470
1872 ...	30·29	30·50	30·05	78·9	97·5	59·3	15·7	127·03	5·05	180	502

These results have been reduced from observations taken daily throughout the year, at 8 a.m.

Height above sea level, 60 feet ; distance from sea, one mile.

R H Bakewell, M.D. ad naturam del.

Observations on the Growth and Reproduction of the Red Corpuscles of the Blood. By ROBERT H. BAKEWELL, M.D.; communicated by Dr. Hector to the Wellington Philosophical Society.

Plate XXIX.

BUT little is known respecting the mode of growth and reproduction of the corpuscles of the blood. The recent discovery of nucleated red corpuscles in the marrow of mammalian vertebrates has thrown some light on the subject, but it is only necessary to read the numerous and conflicting hypotheses as to their formation, which may be found in even the most recent compendia of physiology, to show that nothing certain is known of the matter. The red corpuscles of mammalia are somewhat of an anomaly in the body. Bearing the outward form of cells, having many of the properties of cells, yet destitute of a nucleus, and springing into being as it were without any certain parentage, they have always been the *crux* of physiologists. The writer was led to think that some knowledge of their mode of origin and reproduction might be obtained by growing them artificially, from the results accidentally obtained in the course of observations made on the virus of small pox in the year 1871–72. The writer was at that time physician to the Small-pox Hospital in Port of Spain, Trinidad, and, having taken up his residence at the hospital for the purpose of better investigating the pathology of the disease, was in the habit of collecting the matter from the varioles in capillary glass tubes, such as are commonly employed for vaccine lymph. These, when filled, were taken to the writer's room for microscopical examination. It was not long before he observed a marked difference between specimens taken from the same patient at the same time, according as they were examined immediately, or after an interval of a few hours. It was found that *up to a certain point* the same series of changes which the matter undergoes when in contact with the patient's body in the variolous vesicle would take place in a sealed tube in his room. This room was in a roughly-built wooden house exposed without shade to the tropical sun, and having an iron roof. The temperature was generally at 90° nearly all day, and rarely below 70° all night. Some account of these experiments will be found in papers on the "Pathology and Treatment of Small Pox," published in the 'Medical Times and Gazette' of 1872, and reprinted as a pamphlet. The subject has engaged the writer's attention, and he has been engaged in experiments with vaccine matter and pus at intervals ever since. As these experiments are still incomplete, it would be premature

to say any more about them, than that they satisfied him that not only cells from the vaccine pock would live and grow in the serum of blood, but that the red corpuscles of the blood itself would grow and reproduce themselves outside the living body under favourable conditions, and if supplied with a suitable pabulum. These experiments were made in the following manner :—A small clot from fresh blood, which had coagulated sufficiently long for some serum to exude, was placed in a small glass bottle. The clot usually occupied from 1-5th to 1-6th of the bottle, the remainder was filled by the serum of the same blood, and the bottle carefully closed so as to leave no air between the cork and the contents. Particular attention was paid to this point at first, from the fear that putrefaction would occur if air were allowed to enter. It has since been found that a small quantity of air does not produce putrefaction, and that the bottles may be opened again and again, and their contents examined, without any fear of such a result. The larger sized vaccine tubes may also be used. The first effect of putting the serum on the clot was that the former was immediately reddened by the diffusion of red corpuscles through it. And it will be found that serum thus reddened if put in a cold place requires several hours—twelve at least—before it becomes perfectly colourless again. The necessary movements of corking the bottles, etc., invariably produce a deep reddening of the serum. The first change perceptible to the naked eye when the bottles thus charged have been subject for about three hours to the heat of the human body is that the red corpuscles separate very readily from the serum, and form a stratum at the most depending part of the bottle. At the same time they lose their red tint and become lake coloured. If shaken up, so as to mix intimately with the serum, they very quickly fall down again, and in a few minutes the serum is quite clear of them—as far as the naked eye can see. It looks tinted but is not red. Thus it is evident that the red corpuscles *have changed their colour*, and have become, relatively to the serum, of a greater specific gravity, or they would not so readily subside. It is not established whether the serum has diminished in gravity, or the corpuscles have gained. One thing is certain, that they subside very quickly.

While these changes are going on some kind of gas is formed, as, however carefully the air may have been excluded, a small bubble is always found. In one series of experiments, in order to make certain that no air had got in accidentally, the tubes were closed with melted wax, but the air bubble always appeared. Under the microscope it was apparent that "the red corpuscles were dividing by budding and fissure. Many are elongated and oval, others are nearly divided; there are many small circular bodies of same colour as the red corpuscles, but much smaller." This is copied from notes taken at the time.

The next day another specimen kept under the same conditions is noted as having "great diversities in size of the red corpuscles, but, as a rule, much smaller." The next day it is noted that "there are still red corpuscles dividing, and many in pairs, as if not yet separated. A number of pale cells, like decolourized red corpuscles. All these disappear with acetic acid."

These notes were made primarily with reference to the reproduction of vaccine and pus, and with no intention of experimenting on the red corpuscles which had got in accidentally. About this time, having under his care some cases of croupous pneumonia, the writer examined the rusty coloured sputa, and then found that in specimens distinctly coloured to the naked eye there was either very few, or in some cases no normal red corpuscles, but many presenting various irregular forms, and especially many small spheroidal bodies of the colour of blood corpuscles, and similar to those noted above.

These observations coincided with those made by Beale, as far as the changes in form go, but he does not speak of them as occurring out of the body.

In the sputum of pneumonia many rows of red corpuscles will be seen, somewhat altered in shape, generally much swollen, and arranged like a string of beads. These are often pulled out by the mucus, in which they are entangled. If this mucus be submitted to the heat of the human body for a few hours, in place of these strings of red corpuscles there will be found similar collections of much smaller bodies, evidently occupying the place of the red corpuscles which have disappeared. This experiment must be very carefully performed, as sputum detached from the body, but kept at a temperature of 98·6, will putrify in about six hours, and gives off a most horrible smell. Apparently this is from the mixture of saliva, as mucus hawked up from the throat direct, without touching the mouth, keeps for a much longer time—twenty hours in fact. Possibly the presence of the sulpho-cyanides in the saliva may favour rapid decomposition.

These experiments, of which the details would be tedious, taken together with the fact that the red colouring matter of the blood is diffused through pneumonia (and some other sputum) in a way which never could take place mechanically, convinced the writer that some vital changes would occur in blood removed from the blood vessels, but supplied with pabulum, and kept at a temperature of 98.6.

On thinking the matter over, it occurred to the writer that the nucleated oval corpuscles of birds would be not only much larger, but would show much more clearly the nature of the changes that took place. By this means several inconveniences attending the use of mammalian blood—such as the extreme smallness of the corpuscles—were avoided, but as it was difficult to procure enough serum from the blood itself, in many of the experiments the albumen of the hen's egg was employed, which answers just as well as serum. The

first thing to be noted is that however soon the blood may be examined after being taken from the bird, it will be found to contain not only oval nucleated red corpuscles and circular white ones, but also non-nucleated circular red corpuscles, exactly like those of the mammalia, except that they appeared to be biconvex. These have been seen within fifteen minutes of the blood being taken from the body. It is important to note this fact, as it bears out and explains the changes that subsequently take place.*

The first of these is that the corpuscles become thicker, and the nucleus swells. This is seen very well when the corpuscles turn on their edges. Many of them then, or soon after, become bent or curved, so that their outline when they turn on their side is that of a concave convex lens. (See Plate XXIX., A.) Numerous very minute, bright, highly refracting spherical particles are seen. These do not coalesce, and are nearly all of one size. At the end of an hour's exposure to the heat of the body, it was observed that many of the round red corpuscles (which when the blood was first drawn presented no appearance of a nucleus) showed nuclei; a few oval corpuscles had serrated edges. No change in the great majority.

At the end of twenty-four hours the "red corpuscles had precipitated in the manner previously described; the albumen was much more liquid; nuclei becoming large, round, and well defined; many circular copuscles."

The next change observed is that the shapes of the corpuscles are now much altered, and may be pyriform. Many of the nuclei are double, and are evidently about to divide. Their mode of division is a subsequent stage. They separate widely within the corpuscles, one going to one side or end, and the other to the opposite. (Plate XXIX., A.) In some cases it appears as if the germinal matter divided into four parts. The nucleus becomes elongated and narrow in some cases, and in others spherical and filling out the corpuscles. The nucleus escapes, leaving a gap in the outer part of the corpuscles, which then rapidly shrinks and loses its colour. In subsequent stages it may be noted that the old corpuscular walls are often seen massed together, quite colourless, and their outlines only to be seen by a careful management of the light, and granular, as if undergoing fatty degeneration. After being kept all night in contact with the body the large majority of the oval corpuscles have disappeared; those that remain are much changed in outline, and evidently about to proliferate, while a number of free nuclei are seen, sometimes singly, but usually massed together in groups. (Plate XXIX., B.) At first these neucli are

* Beale also describes in human blood the appearance of red corpuscles of very varied size and shape. I have described some of these varieties, especially the serrated edges, in a paper read before the Anthropological Society, and published in their journal, "On the appearances presented by the red corpuscles of the blood in various races of mankind." Rollet (New Sydenham Society's Translation of Stricker's Histology) also describes several varieties of the red corpuscles.

simply granular, and either round or oval; there are also many circular bodies containing no apparent nucleus.

Some specimens will be found to contain small circular bodies, very transparent, with a dark nucleus in them. These are often grouped together in twos and threes, and sometimes in larger numbers. They are of a size intermediate between that of the free nuclei and that of the red corpuscles, and are evidently nuclei taking upon themselves a cell-wall and contents. In all specimens there are a large number of the brightly refractive particles before spoken of.

If kept for two nights in contact with the body, being exposed during the day to the ordinary temperature (about 65°), it will be found that every oval corpuscle has disappeared. The entire precipitate is composed of the following elements: circular nuclei in immense numbers grouped together, and forming a jelly-like mass in the albumen. To the naked eye the appearance is very much that of the spawn of some of the fresh-water molluscs. Some of these nuclei are slightly granular, and nearly opaque; mostly, however, they have a very distinct outline, and are transparent. In many may be seen, by a careful management of the light, a cell-wall forming round them, at first barely perceptible, and little larger than the nuclei. But others are found with a more distinct and larger cell-wall, and a considerable number are well-defined transparent cells with a highly refracting nucleus. In the latest stage to which their development can be carried before putrefactive changes occur, the nuclei have become converted for the most part into circular bodies of a fawn colour, like that of red corpuscles, some nucleated, some not; some spherical or nearly so, others thick disks. Some of these are elongated or pyriform, others apparently budding. With these are found groups of nuclei, and some of the transparent nucleated cells which have not yet taken to themselves the colouring matter of the blood. It seems as if these circular fawn coloured bodies would, under favouring circumstances, develop into the regular oval corpuscles of the blood, as they have a tendency to assume that shape. (See Plate XXIX., F.)

The steps of the process seem to be as follows :—

1. Swelling of the whole corpuscle, but especially of the nucleus.

2. Elongation of the nucleus, and commencing division into generally two, but sometimes four, parts.

3. Division of the nucleus, and separation of the parts within the wall of the corpuscle.

4. Rupture of the wall and escape of the nuclei.

5. Shrinking, and ultimate fatty metamorphosis of the corpuscle.

6. Agglomeration of the free nuclei into groups or masses.

7. The nuclei take on them a transparent jelly-like envelope, which

8. Enlarges until it assumes the form of a distinct cell-wall with contents, and

9. Absorbs the colouring matter of the blood, while the nucleus becomes obscured, but may be brought out by dilute acetic acid or water.

To show that these changes are really vital, it is worthy of note that the same blood which had been thoroughly dried, and another portion which had commenced to putrify, were mixed with albumen and subjected to the heat of the body, and in both cases nothing but the ordinary putrefaction changes took place, attended with much fœtor, and the growth of multitudes of vibriones, bacteria, etc., etc.

Being desirous of ascertaining the effect of a fever temperature on the growth and development of the red corpuscles, some hen's blood was subjected to the temperature of 104·5 F.; most of the time the latter, but never exceeding 105°. For a short time the temperature fell to 102°, owing to the room having got cold. The blood mixed with albumen of hen's egg was placed in small (½ drachm) corked bottles in a warm bath, which was kept warm by means of a lamp. These experiments need not be given in detail it may suffice to say that while a portion of the same blood and albumen subject to the heat of the human body (98·6 F.) went through the regular series of changes, that subjected to the fever heat hardly underwent any change at all for six hours, when the experiments were given up.

It was curious that this same blood, which had been subjected to the high temperature, after remaining a night and a day in the cold, went through all the ordinary changes enumerated above when put in contact with the human body, showing that though the high temperature retarded metamorphosis it did not kill the blood. Further experiments will be made on this point.

A specimen of mixed blood and mucus, instead of putrefying, as it usually does in a few hours, and giving out so much gas as to blow out the cork and produce a most offensive smell, remained fresh for the whole night. In every case four or five hours has been sufficient to produce putrefaction.

It is also worthy of note that these specimens have been kept at the heat of the human body for twenty-four to thirty hours, and then at the ordinary temperature of some hot summer days, without putrefaction. Yet it is well known that animal substances exposed to a heat of less than 90° will putrefy in from twelve to sixteen hours. But as long as these vital changes are taking place putrefaction does not occur.

There are many interesting pathological questions which may probably be elucidated by this new method of investigation; for it seems to have occurred to none of the eminent men who have employed themselves in researches on the physiology and pathology of the blood to keep it at or near the temperature of the human body in health and disease. Very high temperature,

such as 110·15 has been employed, but never, so far as the writer can discover, a continuous heat of 98·6.

The most convenient method of experimenting is to get some of the small bottles used by homœopathic chemists for their globules, and fill them with the mixture of blood and serum or albumen. By filling them quite full, and then corking very slowly and carefully, all air may be excluded. They should then be stitched into a long piece of calico, and tied round the body under all the clothes. The larger vaccine tubes have also been employed. They can be kept in a case, and one taken out at intervals for examination. There need be no hurry to use the blood immediately after the bird is killed, as the blood retains all its vital properties for twelve hours in a temperature under 70 F.

DESCRIPTION OF PLATE XXIX.

A. Blood of goose mixed with the albumen of a hen's egg, and kept at the normal temperature of the human body for eight hours.

B. Hen's blood and albumen of hen's egg whipped up with air, then kept in a closed tube for eight hours at the temperature of 98·6 F. (36·4 C.)

C. Blood of goose mixed with albumen of hen's egg, kept at 98·6 F. for twenty hours.

D. The same kept for same period in about six times the bulk of its own serum.

E. D treated with dilute acetic acid.

F. Hen's blood kept for about forty-eight hours in albumen of hen's egg, at 98·6 F.

All the above were drawn from the specimens actually under examination, magnified 550 diameters.

Induction and Necessary Truth. By the Rev. R. Kidd, LL.D.

[Read before the Auckland Institute, 6th January, 1874.]

ANALYSIS.

Meaning of the Greek word *epagōgē*.
Aristotle's definition.
Note on a different interpretation.
"Incomplete" Induction. Bacon.
Philosophy of Induction recent, and hitherto confined to England. Whately, Whewell, Herschel, Mill.
Definition of Induction (Mill's). Inductive propositions are general.
The result of an induction is a proposition.
Inductive conclusions are "probable."
Necessary Truth: Analysis of an arithmetical proposition.
Necessary truths are hypothetic.
Definition of Self-evident Proposition.
Definition of Necessary Truth.
Relations of Necessary Truth to Experience: Experience gives the conceptions of things.
Experience verifies.
The distinctions of Inductive and Necessary, and of Deduced and Self-evident, are not absolute, but relative.

It is the purpose of this paper, first, to inquire whether we are in possession of any general truths of which our knowledge is not dependent upon Induction; then, to suggest a definition of Necessary Truth more precise and more real, as it appears to me, than that which is usually given; and thence to indicate more determinately the relations of Necessary Truth to Experience. The results thus arrived at may, on a future occasion, be applied to elucidating the Ground of Induction, or the rational basis of Generalization from Experience.

We shall, therefore, begin with inquiring what it is exactly that we mean when we employ this term Induction; for it is a term in the employment of which there has been much vagueness. It appears to have been first used in its technical application by Cicero, as the Latin rendering of the Greek word which had been similarly applied. In general speech the word *epagōgē*, to which *induction* exactly corresponds, meant *leading onward;* and, when applied specifically to a mental process, it denoted a certain *progression of the mind*, viz., that which consists in being induced, by the consideration of appropriate instances, to adopt some general conclusion. The philosophic appropriation of the term originated with Aristotle—that great pioneer in the analytic of thought, and also in physical observation. It may be somewhat interesting to revert for a little to what we may call the primordial definition of Induction, or that given by Aristotle himself. The most formal definition given by him is comprised in one brief sentence; but, when cited as an isolated quotation, its phraseology is peculiar. The import of Induction is assigned by the old Grecian as follows (Analyt. Pr. II. 23):—"Induction and Inductive Syllogism are the concluding by means of one Extreme (the Minor), that

the other Extreme (the Major) belongs to the Middle." By the Middle Term, in the Aristotelian phraseology, is to be understood a certain Class of things; by the Major Extreme an Attribute ascribed, or to be ascribed, to that class; and by the Minor Extreme a Portion or Portions of the same class. Induction, therefore, as explained by Aristotle, is this: the examining the several portions of a given class of things; the finding that they each possess a certain attribute other than the attribute which constitutes the class; and the inferring that the observed attribute belongs to the members of that class universally. The following, for example, would be an Aristotelian induction: The capability of combining with oxygen is a property of iron, of copper, of gold, of silver, of lead, of tin, etc.; and these constitute the whole class Metal; therefore, whatever is a metal has the property of combining with oxygen. In another portion of Aristotle's works the following explanation is given (Top. I. 12): "Induction is the proceeding from the singulars to the universal. *E.g.*, let us suppose that the person who has knowledge is best as a pilot, and as a charioteer; and, universally, in each department the person who has knowledge is the most excellent."*

The only induction adequately analysed by the ancients was that in which *all* the portions of the class, respecting which the inference is to be made, are supposed to be known by direct experience. But in actual practice the data of induction are of course very rarely capable of being thus exhaustive; and indeed the word Induction is now specially appropriated to what the old logicians called *Incomplete* Induction, viz., that in which only a portion of the class in question is experientially known, which portion is assumed to be a sufficient *specimen* of the whole.

The title, Father of Inductive Philosophy, has been frequently awarded to Francis Bacon. The designation is not quite appropriate, nor yet altogether unfitting. Bacon did not himself extend the domain of experimental science; he did not appreciate duly what some investigators of now illustrious renown had a short time previously effected; his exposition of the methods of investigation was unavoidably indefinite, and it is now perceived to be, in certain most important respects, essentially erroneous. What Bacon did was this: he descried, he deeply felt, and with majestic eloquence he proclaimed and enforced the principle that the great want of mankind in his age, as to science and art, was the extensive observation and strict questioning of nature; with

* Some writers, including Archbishop Whately, assume that *epagoge*, or *induction*, in the logical application, means properly the *bringing in of the instances*; according to which interpretation the correct phraseology would be, "induction of facts," and "inference from induction," not induction from facts. This explanation is not in accordance with the words of Aristotle and other ancient writers. Aristotle remarks (Analyt. Pr. II. 23) that "Induction is *by means of* all" *(epagoge dia panton)*, not Induction is *of* all *(epagoge panton)*. Again, he says, in words quoted above, "Induction" (not inference from induction) "is the *proceeding from the singulars to* the universal *(apo ton kath hekaston* EPI *ta katholon ephodos.)* The word *inductio* is used similarly.

a prophetic exaltation of spirit he stood singly on a Mount Pisgah of science, and vividly enjoyed and depicted a glorious vision of rich achievements to be accomplished; he taught that the way to realize such grand results was, in the first place, to tread a humble path of patient inquiry; and, lastly, he attempted, though he could not succeed in, the construction *a priori* of a logic of experimental discovery.

Without injustice to either Aristotle or Bacon we may say that the Logic of Scientific Investigation is a recent addition to mental science. It has been hitherto developed exclusively by English thinkers. Archbishop Whately was the first who indicated a genuine analysis of the inductive generalization. Dr. Whewell is the historian of the Inductive Sciences; and he has copiously treated of their philosophy. He did, doubtless, exaggerate the prowess of the Intellect in its relation to Experience; but it may be fairly questioned whether his critics of the opposite school have not erred as widely in the contrary direction. It is characteristic of the tendency of Dr. Whewell's mind, that he suggested the avowed innovation of giving a new definition to the word Induction, and assigning a new reference to its etymology. He urges that the inductive result is obtained by means of a mental conception being superinduced upon the thereby colligated facts—as in Kepler's discovery of the orbit of the planet Mars being the periphery of an ellipse; and by Induction Dr. Whewell would have us to understand this *superinducing* of the appropriate conception.* The suggestion, I need scarcely say, has not been adopted. We must not omit mentioning here, though it will suffice to merely mention, Sir John Herschel's instructive "Discourse on the Study of Natural Philosophy." John Stuart Mill, who has recently passed away while still fully exercising the matured vigor of his profound intellect, accomplished the task which Bacon somewhat prematurely attempted, and which has been regarded by many as impracticable—that of constructing a logic of scientific investigation. Mr. Mill defines Induction thus (System of Logic, III. ii. 1): "That operation of the mind by which we infer, that what we know to be true in a particular case or cases, will be true in all cases, which resemble the former in certain assignable respects. In other words," it is added, "Induction is the process by which we conclude, that what is true of certain individuals of a class is true of the whole class, or that what is true at certain times, will be true under similar circumstances at all times." In another passage the same author says (III. iii. 1): "Induction properly so called . . . may, then, be summarily defined as Generalization from Experience. It consists in inferring from some individual instances, in which a phenomenon is observed to occur, that it occurs in all instances of a certain class; namely,

* Philosophy of the Inductive Sciences, Aphorisms concerning Science, No. 13; and XI. v. 3.

in all which resemble the former, in what are regarded as the material circumstances."

In this definition of Induction Mr. Mill is in unison with Aristotle and other ancient writers, and with the popular reviver of Logic, Archbishop Whately. The definitions given by more recent expositors are tantamount. Induction being thus defined, let us now notice explicitly, in order to decisive clearness, some of the properties of Induction which are expressed or implied in that definition.

1. Let us observe, in the first place, that the propositions obtained by induction are *general* propositions. When Kelper tested, one after another, many different positions of the planet Mars, and found that each position would be comprised in the periphery of an ellipse, each of those positions, thus experientially known, was an individual fact, and the statement of them collectively was a statement of actual definite experience; but the inference that *all* the positions of the planet constituted, when combined, an elliptical orbit, this was an inductive generalization. Further, that the planet Mars moves round the Sun in such wise that the radius vector describes equal areas in equal times, and that Mercury and Venus do so likewise; these may be designated as individual facts, or their statement as singular propositions: while it was an inductive generalization, for Kelper and his contemporaries, to conclude that this law of equal areas in equal times was a property of every planet, tested and untested. These generalizations did, of course, cease to be immediately inductive when Newton demonstrated them to be deducible from simpler and more general principles. Again, in the case of numberless bodies of earth, and of many bodies astronomical, it has been ascertained, whether from direct experience or by inference, that matter gravitates to matter; but it is an inductive generalization, and that of the widest kind, that not any matter throughout the universe is devoid of the attribute gravitation.

2. With reference to the definition of Induction, it is, in the second place, to be noted distinctly, that the result obtained is not merely a general *term*, or the conception of a *class* of things; the result of an induction is a general *proposition*, or the ascription to the class universally of some attribute other than that by which the class is constituted. *E.g.*, all matter gravitates: to have obtained the conception of matter, and to have apprehended what is meant by gravitation, are of course results of *experience;* without experience we should be devoid of those ideas, and of all knowledge of those things. But Induction does something more than this; it conjoins the two conceptions or terms in a universal proposition. Simple Experience presents to us individual facts, and thus furnishes us with *concepts;* but Induction leads on to *beliefs*.

3. We are now, therefore, to observe, thirdly, that no inductive generalization whatsoever, no inference from the phenomena of experience, can

transcend the region of *the Probable*—the term probable being here employed, not in the more restricted sense of the popular usage, but in the wider acceptation whereby it includes moral certainty. That all matter throughout the universe gravitates; that when the Sun shall rise to-morrow, his disc will be circular; that of the liquid in an unknown river, the main ingredients are oxygen and hydrogen; that no human being now alive will survive till the year 2073: all these are propositions as to which it may be presumed that no person would entertain any doubt; but yet we may distinguish degrees of difference in our assurance of them. They are results of accumulated evidence; and "probable evidence," as Bishop Butler justly observes, is that which "admits of degrees, and of all variety of them from the highest moral certainty to the very lowest presumption."

It is, then, an essential characteristic of inductive inference, that it does not lead to absolute knowledge, though it can attain to what is practically equivalent—moral certainty. This essential characterestic, however, has been, strange to say, ignored in the discussion of some of the fundamental questions pertaining to the philosophy of Induction; and yet, by due attention to it, we may obtain, I am persuaded, the solution of that peculiar and various amount of unsatisfactory paradox which still disfigures the basis of this department of sciences.

Inductive inference, as we have seen, conducts to general truths. We now, therefore, proceed to ask, are *all* general truths inductive? In other words, are there any universal propositions which we know to be true, and which are such that our knowledge, whether of those propositions themselves, or of those from which they are deduced, is not dependent upon the fact of a verifying test having been applied in a sufficiency of individual instances?

Let us take the arithmetical proposition, the square of 3 plus the square of 4 is the square of 5. This proposition is unquestionably true. And it is a general or universal proposition; for the assertion virtually is, that in any instance whatever of there being an aggregate of things the number of which is the square of 3, and also an aggregate of things the number of which is the square of 4, then in the sum of the two aggregates the number of those things is the square of 5. Now, what is the foundation of our certainty that this proposition is true? It may well be that none of us has ever formally tested the truth of the proposition by actual experiment; and yet none of us doubts it. It is deduced from other propositions; and we are now to see whether those others are inductive. The expression, the square of 3, means 3 taken 3 times; and so also as to 4 and 5. But what do we mean by these words, *three*, *four*, *five*, etc.? As the word *two* simply means 1 + 1, so the word *three* means 2 + 1; and so on until we have defined *ten*. And, further, the word *eleven* means 10 + 1; the word twelve means 10 + 2; and so on until we have defined

twenty. These definitions being assumed, it is demonstrable by the mere substitution of equivalent names, and so performing the enumeration in the abstract, that the square of 3 is 9, that the square of 4 is 16, that 9 + 16 is 25, and that the square of 5 is the same. But those fundamental assumptions, viz., that *two* means 1 + 1, that *three* means 2 + 1, etc., are not inductive propositions; they are not merely results ascertained from repeated experiment. Our knowledge of the proposition that *five* means 4 + 1 is not a moral certainty accruing from accumulated evidence. These propositions are *definitions*, and nothing more. We find, therefore, that the proposition, the square of 3 + the square of 4 is the square of 5, is a universal proposition, the truth of which we know; and that our knowledge of its truth is not dependent upon Induction. And a similar analysis might be applied to all propositions whatever belonging to the pure science of Number.

But it may be said: Definitions are simply explanations of words; and how, then, can deductions from mere definitions demonstrate an objective matter of fact? We must answer that they cannot do so; such a result is impossible. That there are in real existence aggregates of things severally numbering 9, and also aggregates of things severally numbering 16, as to such propositions we have no absolute knowledge further than may be afforded to us by direct perception of individual things. But we have an absolute knowledge of this, that *if* there exist any where an aggregate of things whose number is 9, and also an aggregate of things whose number is 16, in that case the sum of those things numbers 25. Such a proposition comprises a condition as to the supposition of real existence; but we know absolutely the truth of the conditional proposition, which truth consists in this, that the predicate is coextensive with the subject. It may be, or may not be, a matter of fact that there is at the present moment in St. Giles's, London, a mendicant having two pockets, in one of which are four, and in the other three, penny pieces. But it is a proposition of absolute certainty, that *if* there be such a personage so circumstanced he has in his pockets coins to the number of seven. All general propositions asserting unconditionally any matter of fact, or any real existence, are, or ought to be, derived from inductive data: but there are also general propositions expressly or virtually *hypothetic;* and many of these, in various departments of knowledge, are necessary truths, that is, propositions whose truth is known absolutely, and not merely probable or certain according to the amount of experience.

We are now in a position enabling us to obtain a more distinct view of what we mean by a necessary truth. A necessary truth is, of course, a species of proposition or assertion: and all propositions, of whatsoever kind they may be, and however much they may vary in other respects, agree in this, that every proposition consists of a subject and a predicate; that is, a *subject-*

thing is spoken of, and to that subject-thing there is ascribed an *attribute.* What, then, are we to understand by a proposition being *self-evident?* It must be this, that the perception of the subject-thing *comprises* the perception of the predicated attribute; that we cannot perceive the one without perceiving the other. In other words, a self-evident proposition is such that no adequate definition or explanation of the subject of the proposition can be given without its comprising the ascription of the predicated attribute. If, on the other hand, we take any inductive conclusion—*e.g.*, All matter gravitates, All animals having horns on the forehead are ruminant, All revolutionary democracies tend to military monarchy—in such a case we find that the predicated attribute is additional to, outside of, the definition of the subject. But if we take the proposition, 4 is $3+1$, the mere definition of what we mean by *four* gives us the predicate. The attribute, in such an instance, is not additional to, but is included in, the definition of the subject. Again, let us take the axiom, If equals be added to equals, the sums are equal: we cannot give any definition or explanation of what is meant by *equals*, and of what is meant by *adding*, without implying the equality of the sums. Let us, for further illustration, refer to the science of quantity in space. The fundamental axioms peculiar to Geometry are two, of which the first is, that Two straight lines cannot enclose space. This proposition may be resolved into two alternative propositions. Any two lines must either meet one another, or not. As to the first alternative, it is obvious that the perception of two lines not meeting one another comprises the perception of their not enclosing space. And so also as to the second alternative: we cannot have the perception of two lines diverging from a point, and of each of those lines being straight, without our perceiving that the divergence is perpetual. The term "straight line" may perhaps be considered to be undefinable as being the expression of a simple conception; but we may doubtless explain the conception, if requisite, by variation of language, or by whatever means of illustration. We cannot, however, give any explanation of straightness, nor any definition or explanation of "diverging," without implying the perpetuity of the divergence.

In like manner we might explain why the following propositions are self-evident: Two diverging straight lines are not parallel to the same third; Every event has a cause; Causes perfectly similar produce perfectly similar effects.

Such, then, is our definition of self-evident truth, viz., *A self-evident proposition is a proposition such that the perception of the subject-thing comprises the perception of the predicated attribute*; or, it is *a proposition such that any adequate definition or explanation of the subject implies the predicate.* Having this definition, we have no difficulty in completing our definition of Necessary Truth. *A necessary truth is that which is either a self-evident*

proposition, or deduced from data consisting exclusively of propositions that are self-evident. Those ultimate data are definitions and self-evident axioms.

We now proceed to designate very briefly the relations of Necessary Truth to Experience.

1. First, it is from experience that we acquire the *conceptions* of things; so that without experience we could not form any propositions, whether inductive or necessary. But having obtained from experience the conception of a certain thing, or class of things, and the conception of a certain attribute, we are not dependent upon inference from experience in order to decide whether the definition of the subject implies the predicate; or, in other words, whether the perception of the subject-thing comprises the perception of the predicated attribute. If it does, the proposition is self-evident; and all conclusions from self-evident propositions alone are necessary truths, or general propositions whose truth is known absolutely.

2. And, secondly, it is fitting and requisite that recourse should be had to experience, in order to *verify* our judgments. As we are liable to error in the exercise of all our faculties, so we cannot assume to be exempt from fallacy as to distinguishing, in all instances, what may be received as self-evident, or as deduced necessary truth. It was formerly regarded as self-evident that matter cannot act where it is not; but it would perhaps be impossible to reconcile this assumption with now received theories of gravitation.

3. Our conceptions of things, as we have seen, are from experience, and experience verifies our judgments. But, further, it is to be remarked, both as to the distinction of general propositions into Inductive and Necessary, and as to the distinction of Necessary Truths into Deduced and Self-evident, that these distinctions are *relative.* They are distinctions, not of objective things themselves, but according to our faculties and our knowledge. It is recorded of Sir Isaac Newton, that when he first read the treatise of Euclid the greater part of the demonstrations was to him superfluous. If we thoroughly understood the nature of what we call matter, we should doubtless perceive that the supposition of matter devoid of gravitation, or of other experienced qualities, would be self-contradictory. The progress of discovery has been continually removing propositions from the category of being merely or immediately inductive, into that of being deducible from ulterior and wider principles.

The consideration of the subject of which we have been treating is incomplete without some notice of what the chief thinkers upon these topics have pronounced with reference to Necessary Truth; but this paper has perhaps already extended to too great a length. I have also, of course, omitted altogether the application of the results, at which we have arrived, to that very interesting subject, the Ground, as it is termed, of Induction, or the ultimate basis of Inference from Experience.

On Probability.—(Part I.) By the Rev. R. Kidd, LL.D.

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1. There are two portions of the science of Probability which it is the aim of the following observations in some degree to elucidate. Our present inquiry will be as to the exact nature and relations of what we term Probability, a subject which is, I think, partially involved in confusion. On a subsequent occasion we may consider a certain application of the calculus, which appears to me to merit some development, and which has been hitherto unnoticed in almost every treatise on Probability.

2. *(Popular signification of Probability.)*—In common discourse we ascribe probability to a proposition only when we regard it as not certainly true, but more likely to be true than to be false. The term "probability," as thus used, is equivalent to *likelihood* or *verisimilitude.* We find, accordingly, that this is not the primary signification in that language, the Latin, from which the word is derived; and it will not be irrelevant to advert for a moment to its earliest import. Indeed the primary meaning of the word will be found to illustrate very appositely our determination of its present significance. The root *prob* denoted *approbation;* to be probable, *probabilis,* was to be worthy of being approved. In the classical Latin writers the word has both of these significations, viz., *approvable* and *likely;* while the primary meaning alone pertains to the cognate words *probus, probitas,* as to our English *probity, approbation.* We may perceive how the secondary sense flowed from the primary, when we consider that occasions of deliberation respecting the choice of one or other course of *action* would be, in primitive states of society, almost the only occasions of attempting to prove a proposition; and that the most *approvable* course is that from which a good result is the most *probable.* Demonstrations or proofs were not demanded, in primitive times, for history, theology, jurisprudence, or any science; but in all eras of human affairs the meed of approbation is awarded to "sage counsel in cumber."

3. *(Scientific Signification.)*—In technical phraseology yet another application of the term Probability has become established. In this wider signification probability is recognized as pertaining to every proposition of which we do not know either the truth or the falsity. The grades of philosophic probability include downwards all that we consider *possible;* and they range up to all of which we do not consider the contrary to be impossible. And certainly it is fitting to have some designation which shall be thus widely generic. Between the lowest possibility and the state of equipoise of evidence,

and again between this and the highest moral certainty, the successive differences are merely differences of degree, while the shades of graduation may be innumerable. We may refer for an example to the probable duration of life. In the "English Life Tables," calculated by Dr. Farr from the census of 1841, with other data, and published in conjunction with the Reports of the Registrar-General, we find that of the men resident in England, and aged 30 years, one-half is, very nearly, the ratio of those who attain to the age of 66 years. This implies that in the case of an individual Englishman, aged 30, and of whom we do not know that he is other than an average specimen, the probability of his attaining to the age of 66 is equal to that of his dying previously. That he will complete his 65th year is a little more likely; and that he will complete his 67th year is, by a small difference, less probable. But these three probabilities, or fractions of probability, are manifestly homogeneous, the variation, in each instance, being merely a difference of degree, and not a diversity of kind. And we might similarly go on, year by year, through the still diminishing probabilities of survival, to the age of 90 or 100; while on the other hand we might in like manner ascend with constantly increasing likelihood, from the expectation that the individual in question may survive the 66th year, till we should come to the year, the month, the day, through which he is now passing. Although in such a series of propositions the lower grades are not probable, in the sense of being likely to be realized, they have, however, each of them a fraction of probability. In the absence of a term more appropriate, this word "probability" is therefore used with an extended signification, so as to include all the grades of moral certainty, likelihood, unlikelihood, and mere possibility.

4. *(Ambiguity.)*—The important difference between the popular and the scientific applications of the word "Probability" may occasion an injurious ambiguity by ministering to one or other of the twin fallacies of credulity and over-scepticism; each of which is based upon ignoring the distinctions between mere possibility and likelihood, or between lower probabilities and moral certainty. That a speculation almost desperate may eventuate in success, is possible; there is some degree of probability, in the scientific sense, in favor of the expectation: but such a result is improbable, unlikely; and if important interests are involved, to incur such a hazard is unwise. Again, the most cogent circumstantial evidence may possibly mislead; it is, therefore, only a conclusion of probability, in the generic application of the term, that A. B., who is arraigned for murder upon such evidence, is guilty; and, in cases of this kind, it sometimes happens that, in despite of data affording a moral certainty, the moral cowardice of jurors occasions a failure of justice. A like fallacy has been incurred with reference to the tenet, that Mind does perceptibly preside over the operations and evolutions of Nature. I have heard

persons of extensive information, but apparently unacquainted with the nature of Probability, ridicule what they termed "belief in a probable God." Now, whatever may be the merits or demerits of the old theory, that "the invisible things" of Creative Agency are clearly inferrible from their effects, such criticism, at all events, is fallacious. Probability, in the extended application of the term, includes moral certainty; and, furthermore, the probability, in any case, as we shall presently have occasion to notice, belongs to the evidence adduced, and is not at all an attribute of the object of the thought or belief. Probability, it has been well observed, as distinguished from demonstrative proof, is the rule of human life. There are innumerable matters of practical importance, as to which we cannot reasonably look for a direct knowledge, or that species of certainty which is termed absolute. In all such cases the question to be considered is, What is the degree of the so-called probability? Is it of so high a grade as to warrant a rational assurance, and therefore to demand a practical recognition?

5. We now proceed to determine the basis of Probability. It is evident, in the first place, that any supposed event or thing, about which we may cogitate, is either *real* or *unreal*, and that there are no degrees of reality. But in ascribing a probability we do not either affirm or deny reality; and the degrees of probability are innumerable. Probability, therefore, is not a quality of things in themselves, or objectively considered. In the proposition, Hannibal will probably become master of Italy, or, the Duke of Normandy will probably conquer England, it must be allowed that, notwithstanding the grammatical construction, there is no assertion made as to the mode or character of the achievement. New Zealand is probably a remnant of a submerged continent: in saying this, we do not characterize in any way either the submergence of one part or the survival of another; but we intimate that we have much evidence in harmony with that conclusion, while our knowledge of the events is incomplete. To allege that a stated event is probable, in whatever degree, is merely a mode of expression whereby we designate the extent of our knowledge upon the subject as compared with the extent of the statement; and the probability varies according to the varying data of our knowledge. When, by an ominous accident, the eminent statesman, Mr. Huskisson, was killed on the occasion of the first-constructed railway being opened, his death was a matter of certainty to the inhabitants of Liverpool, at the same time that his being alive was a supposition of high probability to a person in London or Kent. The basis of a probability is, then, the amount of our knowledge of the determining circumstances; and this knowledge has respect either to the intrinsic circumstances of the individual case itself, or in general to the attributes of a class of things to which the case in question belongs, or to both of these sources of inference.

6. *(Probability implies imperfect knowledge and rationality.)*—The perception of probability, therefore, pertains to minds that have only a *partial knowledge* of the thing in question, and are *rational.* These two conditions must be combined in order to the perception of probability. To a being omniscient of the relations pertaining to any object of thought, there is, with respect to that object, a full certainty of direct knowledge, so that there is no place for probability. Such, for example, is the case of our own knowledge with reference to abstract relations of number and magnitude. On the other hand, a being totally irrational is incapable of the mental pondering that a perception of probability implies. In a mind devoid of reflection there is no distinction between *vivid impression* and *belief.* The perception of probability implies a combination of imperfect knowledge with rationality.

7. *(Probability is a property of Propositions.)*—We have seen that Probability is not an attribute of the events themselves respecting which we may inquire. It would be idly pedantic to condemn, or on all occasions to refrain from, the usual phraseology, whereby we speak of probable events, facts, etc. ; but it is to be noted that these expressions are authorized only by custom and convenience. Of what, then, is Probability a property ? When we say that something is probable, what is it that we thus assert to be worthy of our acceptance, or to have some degree of acceptibility ?

To ascribe probability to a supposed event is to allege, that the *supposition* of the event's occurrence is a probable supposition ; that it is, in other words, a supposition having a certain amount of *claim* to be accepted as in accordance with fact. A supposition is itself a fact, a mental phenomenon ; but its value usually consists in its relation to another, an objective, fact, whether this be mental or otherwise. Imaginations may be vain, thoughts may be erroneous ; and they are so in proportion as they are inconsistent with objective reality. To designate a probability is to estimate the claim of a supposition or hypothesis as to its being in accordance with fact. To say that the event *A* is highly probable, is to indicate that the supposition of the occurrence of A is to be provisionally received as having an evidence approaching to certainty : to assert that the event B is morally certain, is to declare that the evidence in favor of that conclusion is *practically* equivalent to opportunity of absolute knowledge. Probability, then, is an attribute of suppositions as compared with the known data of objective reality. Now, all suppositions are, or are expressible in, *propositions—i.e.,* declarations or statements ; and they are unsusceptible of full consideration except as so expressed. We may, therefore, assume the following principle, that Probability, like Truth, is a *quality of propositions,* and of propositions only. By saying that a supposed event is probable, in whatsoever degree, we mean that this degree of probability pertains to the supposition of the event, or to the proposition in which that hypothesis or judgment is stated.

8. *(Fact, Event.)*—We may observe, in passing, that while the word "fact," like the word "event," is, according to its etymology, applicable only to a *change* in things, it may, however, be allowably used to signify any reality. It is, for example, allowable to speak of the brightness of the star Sirius as a fact. Any question, indeed, respecting a fact, in this wide sense of the term, is resolvible into a question respecting an event or events. For any evidence, whatsoever it may be, of an existence must be evidence of the existent thing having been, directly or mediately, *perceived;* and a perception is an event. We may, therefore, in treating of proofs and probabilities, employ *ad libitum* the occurrence of events as representing all reality of things.

9. *(Numerical Notation of Probability.)*—In the mathematical calculation of probabilities, the number 1 or unity is employed to signify that the data necessitate the *truth* of the given proposition; 0 or zero signifies that the data necessitate its *falsity;* and the intermediate fractions are used to denote the various amounts of *probability*. Thus, if a probability be stated as $\frac{1}{2}$, this denotes that the truth and the falsity of the proposition are equally probable; if we estimate the probability of a proposition to be $\frac{2}{3}$, we estimate the probability of its falsity to be $\frac{1}{3}$; and so on.

Now, to employ an arithmetical fraction in any real computation implies that we contemplate something or other as divisible into so many equal parts as there are units in the "denominator," and that of those equal parts we take so many as there are units in the "numerator." Thus, if we speak of $\frac{3}{4}$ of a mile, or of a pound, or of X, we mean that if the mile, the pound, or X, be divided into 4 equal parts, then of those 4 our proposition pertains to 3. What, then, it behoves us to inquire, are the equal parts which a fraction of probability denominates?

10. *(Probability and Belief.)*—It has become usual to assume that Probability is the same as *Belief;* and that, accordingly, the amount of a proposition's probability is neither more nor less than the amount of belief given to that proposition. Thus Professor De Morgan says (Formal Logic, chap. 9): "By degree of probability we really mean, or ought to mean, degree of belief. It is true that we may, if we like, divide probability into ideal and objective, and that we must do so, in order to represent common language." And he adds: "I throw away objective probability altogether, and consider the word as meaning the state of the mind with respect to an assertion, a coming event, or any other matter on which absolute knowledge does not exist." And he broadly avers, that even when an error of computation is incurred in deducing the amount of a probability, still the conclusion erroneously arrived at constitutes the probability to the computator; so that precisely the same data may render different probabilities. A similar defi-

nition is given by Sir John Herschel (Edinburgh Review, July, 1850; reprinted in "Essays," p. 376): "As Probability," he says, "is the numerical measure of our expectation that an event will happen, so it is also that of our belief that one has happened, or that any proposed proposition is true." In a very recent work of repute, Dr. Bain's "Logic," published in 1870, we read (III. ix. 6): "Probability expresses a state of the mind, and also a situation among objective facts. As a state of the mind, it is a grade or variety of belief. The highest degree of belief is called Certainty; the inferior degrees are degrees of Probability."

Now, that there are degrees of belief cannot be questioned; but how are they to be enumerated, measured, or weighed? How come we at the denominator in the supposed fraction of belief? And if we assume a denominator, how are we to determine the numerator? Consciousness merely indicates, without much nicety of discrimination, that we know or are ignorant; believe, or doubt, or disbelieve; are more or less certain or dubious. This with respect to each person's own mental phenomena; while as to those of our neighbour we have no direct knowledge whatever. The alleged fractions of belief are, in fact, ascertained, not from definitive investigation into the state of men's minds, but from examination of the objective data to which the belief does or ought to correspond. The quantum of credence, in any given case, *ought* to be approximately proportional to the quantity and quality of the data; but whether it actually is so or not, is a question as to a matter of fact totally distinct from that which is asserted in the given proposition. Probability and belief are not, therefore, identical; but they are, or ought to be, correlative; and the interpretation of the degrees of probability is not to be sought or found in the mental conditions of the investigator. Right belief is correspondent to probability; wrong belief is at variance with probability; and the probability itself is determined by the data. To attempt evolving the logic or calculus of Probability from the metaphysics of Belief, is to set out in the wrong direction; and it would be, at the best, to seek the solution of a problem comparatively easy by substituting what is obscure. The substitution, however, is gratuitous. The probability of a proposition is not constituted by the belief that is actually given to it, whether the belief of an individual, or the average amount of belief entertained by the aggregate of judges, or whatever other standard of actual belief we may select; but, as even the etymology of the word "probability" indicates, it is proportional to the degree of belief or acceptance that *ought* to be given, according to the data of knowledge. Which is equivalent to saying, that probability is determined by *evidence;* and accordingly as a testimony is trustworthy, or an argument cogent, a proposition so supported is proportionally probable or certain, however scantily or extensively the value of the evidence may be recognized.

Of the assumption that Probability is identical with Belief, a further and more demonstrative refutation will present itself, after we shall have referred somewhat more particularly to the numerical notation of Probability.

11. *(Probability is neither wholly objective nor wholly subjective.)*—In the foregoing remarks it was requisite, first, as is usually done, to disentangle the subject from the current forms of expression, which would imply, *prima facie*, that probability is a quality of things in themselves, or as objectively considered. We also find it necessary to obviate the other extreme, whereby it has been assumed that Probability is simply Belief. Being aware that Probability could not be identified with the objective, writers of deservedly high repute have unwarily adopted the opposite and less obvious fallacy of making Probability to be merely *sub*jective. Dr. Bain, in the passage quoted above, appears to have contemplated the untenableness of wholly identifying Probability with Belief; but he has recourse to an expedient not less untenable, when he assumes that there are two kinds of Probability, the one resident in the mind of the investigator, and the other in the objective facts. This assumption is made tacitly, and is entirely unsupported. The simple truth is, that Probability is neither wholly objective, nor wholly subjective, inasmuch as it is a claim to acceptance constituted by a *relation* between the two. Probability is not, on the one hand, a quality of the things themselves respecting which we inquire; nor, on the other hand, does it consist in any mere condition of the mind of the inquirer. The probability of a proposition is the value of its claim to acceptance as being true, or in accordance with fact; and this value is estimated by comparing that which is asserted in the proposition with the data that we know. The knowledge is in the mind of the reasoner, and the proposition which states the probability, and which ought to be in accordance with that knowledge, is framed in his mind; but the data thus known are objective, and the probability of the proposition is its claim to acceptance as constituted by the relation of those data to the matter treated of in the proposition.

12. *(Basis of the Numerical Notation.)*—It is now requisite for us to analyse some easy examples of numerical probability, in order that we may be enabled to designate more definitively the principles involved.

Let us suppose that we know an event, which we may call *A*, to have occurred on some day in the month of June, and that this is the whole of the data: we would estimate the probability of the following proposition, The event A occurred before the 21st day of June. As June consists of 30 days, all equal to one another, the case is distinguishable into 30 alternatives having equal claims upon our acceptance; and of these 30 alternatives the proposition in question is affirmed by 20, representing two decades of days. The whole case, therefore, is appropriately expressed in the following three alternative propositions:—

(1.) The event A occurred in the first decade of June; or,

(2.) It occurred in the second decade; or else,

(3.) It occurred in the third decade.

That the event occurred on a day of June is assumed to be known: the numerical representative of this proposition is, therefore, the integer 1; and, consequently, as each of the three alternatives constituting the case is equally probable, the probability of each is represented by the fraction $\frac{1}{3}$. But the proposition in question, viz., that the event occurred before the 21st day of June, is true, if either of the first two alternatives be true; while it is false, if the third alternative be the true one. The probability of the proposition, therefore, as furnished by those data, is $\frac{2}{3}$.

The following familiar example is noticeable as presenting an easy problem, in the solution of which a celebrated mathematician erred, and as illustrating, accordingly, the fundamental distinction that there is between Probability and Belief. Let us suppose a coin to be taken such that, when it is thrown, either side of the coin is equally likely to fall uppermost. The probability of the obverse side falling uppermost in any throw is $\frac{1}{2}$; for the case is comprised in two equal alternatives, one of which affirms, and the other negatives, the proposition in question. Let us now further ask, What is the probability of the obverse being shown in one or other of two throws? This case consists of the following four alternatives:—

(1.) Both throws show reverse; or

(2.) The first throw shows reverse, and the second obverse; or

(3.) The first throw shows obverse, and the second will show reverse; or else

(4.) The first throw shows obverse, and the second also will show obverse.

These alternatives being all equally probable, and their number being 4, while it is assumed that one or other of them is certain to occur, the probability of each alternative is $\frac{1}{4}$. But any one of the last three alternatives affirms the proposition in question; so that the probability of the proposition is $\frac{3}{4}$. This implies, that if the experiment were repeated a large number of times, the obverse would be shown by one or other of two throws in three-fourths of the instances or thereabouts; and such experiments have actually been made with results correspondent to the theory. But the eminent encyclopedist of the last century, D'Alembert, inferred from the same data, that the resultant probability is $\frac{2}{3}$. He did not take into consideration that, in order to obtain the accurate estimate of a probability, there must be equal quantities represented by the units of the denominator. We may, of course, divide the case into only the three most obvious alternatives, viz., those of reverse in each throw, reverse in the first throw and obverse in the second, and obverse in the first throw; but these alternatives do not present equal claims upon our acceptance.

The last of the three is, as we have seen, distinguishable into two, each of which has the same amount of probability as the first or second alternative.

One other example we may adduce, which also was miscalculated by a notable personage, the eminent philosopher of our own day, John Stuart Mill. Suppose that a thing, which we shall call *T*, is a member of the class *A*, and that of the members of this class just two-thirds have the attribute *X*; also, that the same thing T is a member of another class, viz., *B*, and that in this class the same attribute X pertains to just three-fourths of the members—the membership in the one class being assumed to be unconnected with that in the other: what is the resultant probability that the thing T possesses the attribute X? In the earlier editions of the "System of Logic" this question was answered erroneously; but subsequent editions gave the correction. The discussion occupies several pages of that work, and is rather abstruse; but by our having recourse at once to the fundamental principle, that of dividing the case into *equal alternatives*, the solution becomes easy. Two-thirds of the class A is the portion possessing the attribute X: we may, therefore, consider the class A as consisting of *sets* each composed of three members; and of each triad let the first two possess the attribute in question, and the third want it. The members of each triad we will designate as A_1, A_2, A_3. Similarly, the class B consists of quaternions, in each of which we designate the members as B_1, B_2, B_3, B_4; and of these let the fourth alone be without the attribute X. The whole case, then, consists of the following 7 alternatives :—

(1.) T is A_1 and B_1, or
(2.) T is A_1 and B_2, or
(3.) T is A_1 and B_3.

These are the first three alternatives; and we have now exhausted A_1, because T cannot be A_1 and B_4; inasmuch as A_1 has the attribute X, and B_4 wants it. The remaining alternatives are, therefore, as follows :—

(4.) T is A_2 and B_1, or
(5.) T is A_2 and B_2, or
(6.) T is A_2 and B_3, or else, lastly,
(7.) T is A_3 and B_4.

Of these seven equal alternatives, one or other of which must be true, the first six affirm the proposition in question, viz., that T possesses the attribute X, and the last alternative alone negatives it; so that the resultant probability of the proposition is, at the most, six-sevenths. Mr. Mill mistakenly inferred the resultant to be eleven-twelfths, until set right by a mathematical friend. It would occupy too much of our time and attention to exhibit here the manner in which the error was incurred.

To assign, then, a fraction of probability implies that the case presents a certain objective *quantity*, of whatsoever kind it may be. This quantity is

considered as divisible into so many equal parts as there are units in the denominator; and the proposition in question predicates respecting so many of those parts as there are units in the numerator. In the first of the three instances that we have examined, the denominated quantity is the days of June, considered as 30 in number, and all equal to each other; of which 30 the proposition in question predicates respecting two-thirds. In the second instance, the unit of the denominated quantity is two throws of a coin; and the denominator is the number of the modes in which these two throws may be varied. In the last of our examples the unit is a member of each of the classes A and B; the denominator, 7, is the smallest number of instances that can exhibit an average specimen; and the numerator, 6, is the number of the instances to which the proposition in question applies.

I have referred thus explicitly to the quantities which furnish the fraction of probability, for the purpose of its being rendered palpably plain that the basis of the probability is objective. For general purposes the fraction of probability is sufficiently interpreted by our saying, that the denominator of the fraction is the number of equally probable alternatives into which the case is considered as distinguishable, and that the numerator is the number of those alternatives which affirm the proposition in question.

13. *(Hypothetic estimate of Alternatives.)*—The supposed simple cases of probability which we have taken as examples for analysis, belong to that class of probabilities in which the alternatives can be distinctly perceived to be equal. But in the actual affairs of life this condition is less frequently realized. In such cases, nevertheless, the numerical notation of probability is sometimes employed for the purpose of more convenient discussion, especially in the combination of probabilities. In the formation of such hypothetic estimates the import of the probability, and of the fraction representing it, is essentially similar to the foregoing. Let us, for example, suppose the proposition in question to be, that the author of the Letters of Junius was Sir Philip Francis; and let us suppose that we estimate the probability of this proposition as being adequately represented by the fraction four-fifths. We cannot, it may be assumed, distinctly assign five equal alternatives, as constituting the case; but supposing that we have found four-fifths in favor of the given proposition to be a fitting representative of the probability, we consider that *if* the case, as known to us, were distinguished into equal alternatives, then about four-fifths of such alternatives would affirm the given proposition. In passing from a case of numerically definite quantities in the basis of the alternatives, to a case not susceptible of a like distinctness of enumeration, we lose the categorical precision in the data; but it is still the mutual relation of the same two things that determines the probability of the proposition, viz., the relation of what is asserted in the proposition in question to the data that are known.

14. *(Inference of Belief.)*—It is now desirable, in conclusion, to revert briefly to the question as to the relation of Probability to Belief. The subject has, in several of its aspects, so much of importance or of interest as to render it worth while to have investigated it closely. It is, then, to be observed, that if the statement of a probability asserted simply the existence of a belief, or of a fraction of belief, there could be no such thing as a demonstrative deduction of probabilities, even from data absolutely assumed. But all agree that from assumed data there are demonstrative deductions of probabilities.

Let us advert to any case whatever of inference of the simplest possible kind. Employing the usual symbolic syllogism—Every M is P, S is M, therefore S is P—we may attach to these alphabetic symbols whatever meaning we please. If the data were merely, that each of those two premises is *believed* by a given individual, whom we may call X. Y., we could not infer absolutely that X. Y. believes the conclusion. He may not have put the premises together; or he may be so unreasonable as not to accept the consequence. If we assume that he has combined the premises, this is an assumption additional to that of the two beliefs. Let this additional assumption be made, and then we may infer, as a high probability, that X. Y. believes the conclusion; because, in the great majority of instances of believing and comparing the premises of a syllogism, the conclusion also is believed. And it is morally certain that if a hundred persons were experimented upon, especially if at all a favourable specimen of rationality, then, in most or all of the hundred instances, the putting together of believed premises would be accompanied by a belief of the conclusion. But these are inferences from an induction of facts not given in the original premises; they are not demonstrative inferences, nor inferences from the mere beliefs of X. Y. or his fellows.

Thus we see that, even with respect to the plainest cases of necessary sequence, we cannot from mere belief demonstrate belief. And why? Because every act of belief is a distinct *event;* and, as in the case of other matters of fact, we do not know the machinery of the causation so well as to reason absolutely. We know absolutely that if every M be P, and S be M, then S is P; but we do not know absolutely, with reference to any person whatever, that if he believe those premises, he also believes this conclusion.

And if a person's belief of the premises of a syllogism in "Barbara" does not of itself enable us to infer his belief of the conclusion, much less would his belief of two separate probabilities warrant our inferring his belief of their resultant. D'Alembert believed that if a given coin were thrown twice, the probability of the obverse side falling uppermost would be in each throw $\frac{1}{2}$; but the great mathematician failed to believe the necessary resultant, that the probability of an obverse in one or other of the two throws is $\frac{3}{4}$. Reasoning

from data almost as simple, the profound philosopher Mill arrived at a resultant probability widely different from the demonstrable conclusion. Allowing, as all do, that the sequence of numerically expressed probabilities is a matter of rigorous demonstration, we cannot consistently deny that Probability is something else than Belief.

The relation of Probability to Belief is more correctly delineated in the older writers than in the most recent. "Probability," says Hume (Essays), "arises from a superiority of chances on any side; and, according as this superiority encreases and surpasses the opposite chances, the probability receives a proportionate encrease, and begets a still higher degree of belief or assent to that side in which we discover the superiority." The real relations are here indicated: the "chances," *i.e.* alternatives, determine the probability; and this probability, *so far as we "discover" it, "begets"* a correspondent belief. The definition of Probability given by the chief writer on the philosophy of Induction, Mr. Mill, is also essentially correct. The "probability to us," he observes (System of Logic, III. xviii. 1), "means the degree of expectation which we are warranted in entertaining by our present evidence."

The distinction between the *actual* belief and *due* belief, which is slurred over by some writers who identify Probability with Belief, is fundamental; and the resultant diversity is great. To ascertain actual beliefs, we must interrogate men's minds; to estimate the degrees of belief that are warranted, we must look to the objective evidence of facts. As the eye does not cause or constitute the rays of light, nor their abundance or paucity; and as the ear does not produce the acoustic vibrations of the atmosphere; so neither does the recipience of the mind create the evidence that is presented to it. And as visibility, therefore, differs from seeing, and audibility from hearing, so probability differs from belief.

15. In concluding these remarks on the nature and basis of Probability, permit me to summarize in a few words the principal results at which we have arrived, in so far as they appear to be peculiar to this paper.

First, Probability is a property of suppositions or propositions, and of these only.

Secondly, the most appropriate definition of Probability appears to be simply this: The probability of a proposition is its claim to be accepted as true; and the value of the claim is determined by the relation of what is predicated to the data. As Truth and Falsity, strictly so called, are properties of propositions only, and Probability is the claim to be true, hence, as above mentioned, it is only to propositions that Probability also belongs.

Thirdly, when a numerical value is assigned to a probability, the denominator of the fraction represents some quantity, of whatsoever kind it may be, which is assumed to be an object of thought, and to be divisible into equal

parts. The numerator is the number of those parts to which the proposition in question applies.

Fourthly, the identification of Probability with Belief, to which recent writers have been prone, is untenable. It is an extreme reaction against that which is implied in some usual forms of expression, whereby probability is attributed to things in themselves, or as objectively considered.

Fifthly, and lastly, Probability is neither wholly objective nor wholly subjective, being constituted by a relation between the two. The knowledge of the data, and the hypothesis of what is not in the data, are in the mind of the investigator; while the data known, and the circumstances of the data, are objective.

What is Science? By the Rev. R. Kidd, LL.D.

[*Read before the Auckland Institute, 29th June,* 1874.]

The present age is allowed to be eminently an age of scientific advancement; and the word Science is one that we do very frequently employ. And yet it is not by any means an easy matter to obtain a precise answer to the question, What is Science. In any books which I have an opportunity of consulting, including works on the history and philosophy of Science, I have met with only one passage even purporting to be a formal definition, except in dictionaries and encyclopedias; and I have not anywhere found a definition such as would appear to me to be adequate. The subject is one not unfitting to be noticed in an institute of science or of literature.

There are two ways of defining the application of a term. One, the ruder, way is to enumerate the objects to which the term is applied. Such, for instance, is the case with the legal word Felony, in its modern usage. It is not now practicable, I believe, to specify any attribute which pertains to every act of felony, and to felony alone. All that the jurisconsult can do, by way of defining this word, is to tell us what indictable offences have been, and what have not been, authoritatively pronounced to be felonious. It is quite conceivable that some similar defect of connotation should be the case with the applications of the term Science; but we are not to acquiesce in such an alternative, except in the last resort. The more satisfactory kind of definition is that which declares, not merely what the word denotes, but what it connotes; that is, a definition which does not simply enumerate the objects to which the word is applied, but states the attributes or properties by which the class bearing that name is characterized. In any case, however, it will be

well for us to begin with enquiring what are those departments of knowledge to which the appellation Science has been assigned by authoritative usage. Custom, as Horace tells us, is that to the arbitrament of which belong the law and rule of expression; but it is generally found that determinations of custom are based on some substratum of reason.

The Latin word *scientia* meant simply *knowledge;* and in the ancient classics we do not find the special and modified application which the word Science has now acquired. The word *art* was used by the Latins to denote, not only what we so designate, but also what we term science.* Mathematics, for example, was called an art; and the sciences in general and scientific arts were termed the *liberal arts; i.e.*, arts and sciences befitting a free man or a gentleman. Thus, in a familiarly quoted passage, a Latin poet (Ovid) expresses himself to this effect:

> A faithful learning of the nobler arts
> Gives mildness to the character and conduct,
> Nor suffers man to be a savage still.

Of this old meaning of the word Art traces remain in our English literature. Pope appears to use the term as equivalent to the acquired signification of the word Science, when he says (Essay on Criticism):

> "One science only will one genius fit,
> So vast is art, so narrow human wit."

The transition from the ancient signification of the word *scientia* may be observed in the works of Francis Bacon. He made partitions of the sciences, as he expressed it ("partitiones scientiarum"); but what he classifies and subdivides is the sum-total of human learning, history and poetry being included. Bacon died in the year 1624. In Locke's "Essay concerning Human Understanding," which was published in 1690, in the last chapter of that great work, there is a classification of the sciences. They are there distinguished into three departments; the first of which is Natural Philosophy, or the science of existent things and their relations. "The end of this," observes the author, "is bare speculative truth; and whatsoever can afford the mind of man any such, falls under this branch, whether it be God Himself, angels, spirits, bodies, or any of their affections, as number and figure, etc." The second department of science, in Locke's classification, he names Practical; of which the most considerable branch is stated to be Ethics. To the remaining department he assigns the several names Semeiotic, or the Doctrine of Signs, or Logic. It may be remarked that the classification to which Locke's analysis thus conducts him, is virtually the same as the ancient Greek division of philosophy into Physical (or Natural), Ethical, and Logical.

The next most notable authority, in the order of time, is the French *Encyclopédie*, published in the middle of the last century. D'Alembert, the

* "Ars enim earum rerum est, quæ sciuntur."—Cic. de Or. II. vii. 10.

writer of the preliminary treatise, applies the term Science to all the branches of knowledge that now receive this appellation, so far as they were then developed, and to none others. The phraseology, in this respect, of subsequent writers has been almost uniform. The older sciences have retained the appellation; and new accessions of knowledge have received it, accordingly as they have become assimilated in character to those which had been previously formulated.

By all authorities whatsoever the Pure Mathematics are denominated sciences. In the case of Logic, and some other portions of mental philosophy, a similar uniformity of usage has been exhibited throughout, with one signal exception, that of Comte. In his classification of the sciences, that eminent, but fanciful, thinker omits what is called Mental Science. This omission, however, has been subsequently disapproved of by all authorities alike, whether friends or foes of Positivism, whether disciples or dissentients. The exclusion of Logic from the reputed domain of Science would not affect the definition of Science which I propose; but it is worth while to notice, in passing, that such an exclusion is alike unsupported by the weight of authority, and would be in itself unreasonable. Whatever the human mind may be, whether merely nerve and blood, or comprising elements transcending our cognizance; whether an act of thought is simply a scintillating snapping of cerebration, or something else in addition to cerebral expenditure, and of a nature yet more recondite; at all events, thought is a positive fact; the results of thought take their place, and not the least important place, among the phenomena of the universe; and the analysis and classification of thoughts are manifestly not to be obtained from the appliances of Mechanics and Chemistry. Thought is impalpable and imponderable; but so are several of the powerful agents of nature, whose effects are analyzed, measured, and gauged by methods which the positive philosophy does not fail to recognize. Thought is invisible; but so are heat, air, and other agents; nay, we do not, strictly speaking, see even the light itself, but only the bodies from which it emanates or is reflected. A moonless sky is traversed by the rays of the Sun, although we cannot perceive them. We may, in fact, so far as the scientific position of Logic and Psychology are concerned, adopt the dictum of that great authority, Mr. Punch, who has uttered the following deliverance:—

> **"What is Matter? Never mind.**
> **What is Mind? No matter."**

This may be interpreted as a facetious way of putting a common-sense truth, that however inscrutable the nature in itself of matter or of mind may be, still the operations of both the one and the other are cognizable in their effects, and the two classes of phenomena thus designated are, as to our perceptions, distinct. The actions of the mind are a portion of the phenomena

of nature; and the analysis, deduction, and induction, of the mental operations cannot be reasonably or consistently omitted from a classification of the sciences. I repeat, however, that the omission would not, in my opinion, alter the due definition of Science.

Natural History also, in its various branches, is now almost unanimously designated as Science. In short, we find that, with a near approach to unanimity, this appellation is given to Pure Mathematics, to Logic, to Natural Philosophy or Physics, to Natural History, to Psychology, to Ethics, to Political Economy, and whatever others. Max Müller names the department of investigation in which he occupies a place so distinguished "the Science of Language"; and he even proposes to construct a "Science of Religion." We hear also occasionally about the science of history or of historical criticism. Such is the wide range of the appellation Science; and our question is, Has this term, in all its recognized applications, a common connotation, and if so, what is it?

This question does not require our engaging in any elaborate classification of the sciences, or reviewing the classifications that have been made; but, for the purpose of our inquiry, there is one obvious distinction requisite to be applied, viz., that between the Demonstrative or Abstract Sciences and those which are Inductive or Experimental. To the former class belong the sciences of Pure Mathematics, and also Formal Logic. Like the applied mathematics, Logic may also be, and is, treated as inductive. The necessary sequence of the logical formulæ from self-evident principles is unquestionable; but it is a further inquiry, how far the actual phenomena of the human mind are represented by those formulæ. Something of the same kind presents itself in Mechanical Science. The fundamental proposition of the composition of forces, called the Parallelogram of Forces, is deducible from principles that may be accepted as self-evident; and multitudes of results are derived from that proposition with the aid of pure mathematics; but yet it is usual and right, in treatises on Statics and Dynamics, to adduce the specific testimony of experience.

Every portion of science, then, is either demonstrative or inductive, or both. By "demonstrative" I mean, deduced by necessary sequence from self-evident principles; while an inductive result is, of course, a finding of experience. Now, of the definitions of Science that I have met with, each is applicable either exclusively to Demonstrative Science, or exclusively to that which is Experiential The definition given in the *Encyclopædia Britannica*, the eighth or last edition, is perhaps an exception. It is as follows:—"Science, in its strictest sense, is a body of organized knowledge, whose phenomena are arranged so as to exhibit the reasons or causes by which they are influenced, in their legitimate connection and interdependence." To this definition there

is annexed the distinction into the two classes of sciences, as follows:—"That science which deals with the succession of reason and consequent, is called an abstract science; while that which deals with cause and effect is called, for the most part, a natural or physical science." To the foregoing definition there appear to me to be several weighty objections, some of them insuperable. In the first place, the wording of the definition is vague and loose: phenomena are said to be influenced by "reasons," these being distinguished from "causes"; and, again, it is not easy to understand what is meant by the "*legitimate* connection and interdependence" of phenomena. The definition, moreover, does not adequately recognize the sciences called Classificatory, such as Botany. These sciences do not deal exclusively with the ascertainment of causes and effects; they are conversant mainly with the determination of *concomitants.* Furthermore, there is not afforded, in the explanation referred to, any definition of Science, taken collectively, but rather two definitions, incongruously combined, pertaining severally to the two classes of sciences, the demonstrative and the inductive.

It has been said to be the characteristic of Science, that it predicts; but this statement requires limitation. Not all science predicts; not all that predicts is science. Demonstrative or abstract science does not predict; and the same may be said as to much of mixed science: albeit the *application* of the sciences enables us to make predictions. But so also does the application of unscientific knowledge. An untutored and unreflective savage can foretell many of the phenomena of nature. The predictive character of science is a fact to be noted, and is exceedingly interesting; but still the power of prediction does not so characterize Science as to furnish its definition.

All science is knowledge, although not all knowledge is science. Of the things that we know, some are individual events, and others are general truths, or, as I prefer to express it, for the purpose of avoiding ambiguity, generic truths. Of the generic truths that we know, a portion is self-evident; but these do not of themselves constitute any science; and all the others are matters of inference. Science, therefore, in the abstract, is *the valid inference of generic truth.* By an inference being valid I mean, that the data or premises from which a conclusion is derived are known to be true and that the sequence of the conclusion from those data is perceived to be cogent. Wherever these conditions are realized, whatever the subject-matter treated of, there we have scientific knowledge; and if any of these conditions be wanting, there is an absence of science. All valid inference of generic truth is essentially scientific; but, in order to constitute what is termed *a* science, there must be a series of generic truths connected by some special relations. *A science*, therefore, in the concrete, we may define *a formulated department of generic truths legitimately assumed and inferred.*

The word Science, used as an abstract term, like the word Philosophy, has a range of application that goes beyond the limits of the sciences, *i.e.*, of the departments of generic knowledge which have been developed and methodized. One science is more complete than another; and some departments of generic truth have not been formed into sciences. It may be that such a department awaits further development; or it may be that its dimensions are too scanty for its receiving a designation, viz., that of being *a science*, to which custom has assigned a certain quantum of amplitude. But the narrowness of the area cultivated does not necessarily affect the quality of the cultivation. The treatment of a subject may be scientific, whatever the subject may be. As all Science is the valid inference of generic truth, so also all valid inference of generic truth bears the character of Science. Such expressions, therefore, as the science of historical criticism, the science of grammar, the science of probability, the science of jurisprudence, and the like, are not merely authorized by custom; they are in strict accordance with the whole rationale of the subject. If generic truths have been validly inferred, such an ascertainment and contemplation is scientific, whether or not those inferences have been made to take their place in an extensive and formal system.

The word Science, used as an abstract term, is cognate to the word Philosophy; and in many instances the two terms are interchangeable. The distinction seems to be, that the designation Philosophy is usually understood to be more especially appropriate to the ultimate generalizations.

The foregoing definition applies alike to demonstrative and to inductive science; and to sciences of classification, not less than to those which are wholly occupied with determining the relations of cause and effect. When we classify, we assume generic concomitance of attributes or properties; and this concomitance is to be validly inferred from induction of experience.

One observation only remains to be made. Science has been defined above to be the valid inference of generic truth. But what may seem to be individual facts, are designated as facts of science. It is, for example, a scientific fact that the diameter of the planet Jupiter has a length between ten and eleven times that of the earth; or that a transit of the planet Venus occurred in 1769, and will occur before the close of 1874. On consideration, however, it is perceived that such knowledge as this is not devoid of the character of being generic. The length of Jupiter's diameter is not an event, isolated or temporary; it is a permanent fact, and is known by inference from generic truths. The transits of Venus at the specified times, and with the specified circumstances, are scientific facts only by virtue of their generic character, by their being instances of generic truths which have been validly inferred. Hence it is that copious details of such an event can be so

accurately and lucidly expounded months or years before its occurrence. Not all generic truth is immediately predictive ; but all human predictions whatsoever are based on generic truth.

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